AGRICULTURAL ENGINEERING

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Stubble Mulch...

New Way to Save Soil and Water

Nature is no nudist. She never lets soil be naked if she can help it. Her method is to keep soil covered with some kind of vegetation, living or dead. Either way, it breaks the bullet-like force of falling rain, aids absorption, and slows down the remaining run-off to a pace that will not wash.

Stubble mulch is the practice of this principle in farming. It calls for tillage without turning, for killing weeds without covering or disturbing surface trash to any extent, for planting and cultivating crops beneath the blanket of decaying vegetation.

Three things are the main keys to stubble-mulch farming—sweeps, coulters, and long, slender shanks. Sweeps of special design slice the soil at desired depth, killing weeds by cutting off their roots and leaving their tops standing. Disks or coulters cut through the trash to make way for shanks or standards. Slender shanks on sweeps, drills and planters simply part the mulch and let it fall back into place.

Sweeps are used on tractor toolbars, on lister beams, on the shanks of duckfoot field tillers, or on special subsurface tillers. A half-way approach to stubble-mulch tillage has long been practiced with the one-way disk plow. It should be set to cut off weeds and volunteer growth, yet leave much of the trash above ground. In some sections, farmers use plows with moldboards removed for subsurface tillage.

For breaking up coarse, bushy trash, and for crushing clods, a "treader" is usually needed. This is simply a rotary hoe with wheels reversed so they turn in the opposite direction from normal. Planters fitted with double disks and stub runners are readily arranged to work through the mulch. Drills with certain styles of single-disk furrow openers do a good job of seeding even when the mulch is heavy. Row-crops are cultivated with sweeps and a small disk on each side of the row.

New to most farmers in most regions, stubble-mulch has proved itself over periods of years in the Northern Great Plains and has showed much promise in scattered trials all the way to the Piedmont belt. Soil is saved most effectively, especially in combination with other conservation practices such as contour cultivation. Yields usually are as good, often better, than with prevailing tillage methods.

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Later on you may get special implements for stubble-mulch methods, but you can begin with what you have now. In the scene shown above, tall stubble is being subsurface tilled with tool-bar and sweeps on a Case "DC" tractor. Consult your Case dealer or write us regarding the adaptation of your Case implements to stubble-mulch methods. J. I. Case Co., Racine, Wis.

CASE ★ ★ ★ ★

SERVING AGRICULTURE *Since 1842* IN PEACE AND WAR

As a service to agriculture, this message is appearing in farm papers. It is one of a series urging farmers to adopt advanced practices, using equipment they already have to promote war-time food production and conserve agricultural resources. J. I. Case Co., Racine, Wis.

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AGRICULTURAL ENGINEERING

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EDITORIAL

Production vs. Peasantry

AT THE informal luncheon meeting of members and guests of the American Society of Agricultural Engineers held during the Farm Chemurgic Conference in Chicago late in March, two views came forth from the same set of facts. The undisputed figures were that 84 per cent of America's farm production come from one-third of the farms, while another third of the farms contribute only 3 per cent of the production. Bracket for bracket, one farm is 28 times as effective as another farm in furnishing food and fiber for the war effort.

One view is that high-producing farms should get all or most of the limited labor, machinery, fertilizer, etc. On such farms each hour of work and pound of material should bring the greatest return of crop and livestock. The other view is that now is no time to sacrifice even so small a fraction as 3 per cent of our farm production; that every possible pound is needed.

As we see it, the latter view would be sound if available acreage were the limiting factor in our total production. Such is not the case; instead it is limited labor, equipment, and supplies to push production on our lavish expanse of lush acres which set the ceiling for food production. And so, as a war production measure, we favor the first view.

There has been too much talk about farming as a way of life. Mining coal and putting in plumbing are ways of life, too. No one advances the philosophical fantasy that those ways of life are so beautiful that a third of the people therein should continue indefinitely producing practically nothing and earning practically nothing. We believe that life can be as beautiful and human nature as noble on good land and in profitable farming as in poverty of soil and substance.

We have no patience with people who would subvert the war effort for purposes of so-called social gain. But when measures to speed up the war effort give every promise of leaving a large part of our farm population permanently better off, either on better land or in more lucrative occupations, we see no sense in trying to impede them. There is nothing to gain, either now or later, by perpetuating peasantry.

Figure on Inflation

WITH THE two most powerful pressure groups in the country both bending every effort toward inflation, and with political timidity preventing any adequate countermeasures, we shall be something less than realistic if we fail to face the probability, if not the certainty, of a badly depleted dollar with which to carry out our postwar plans for the restoration and improvement of farms. This discount of the dollar will handicap every phase of agricultural engineering progress, but will be especially severe as it affects farm structures.

The irony and the tragedy of it are that neither agriculture nor labor needs the inflation they are creating. As a percentage of wages, food costs have recently reached the lowest level in history. Likewise, labor costs have dipped to the lowest percentage of farm income that has prevailed in many years. Farm income more than doubled in the first three years of the war. If there were statesmanship among the leaders of labor and of agriculture, they would unite in one voice to hold down both wages and prices. Instead, they incite their followers to bitter rivalry in speeding the spiral of inflation.

Meanwhile interest and dividends, the earnings of capital, have come down to a substantially smaller percentage of the national income. That may seem good to those who seek the extinction of capitalism by the extermination of capital. But it means that the buffer between wages and prices is being worn wafer-thin; as the cushion under the the ceilings disappears, the ceilings are bound to break. And whether business, with its coffers drained, can convert quickly to a peacetime basis and afford full postwar employment is a darkly dubious question.

No doubt we now should do everything in our power to limit the degree of inflation. But we also must devote our best thought toward measures which will minimize the impact of inflation on agriculture.

Let Them Buy Bond

AS THIS is written, the eight-column headlines of the nation's newspapers are absorbed in the issue of ultimate authority in America; whether it shall be vested in the duly and trebly elected chief executive or in a postgraduate gorilla. Twenty pages toward the back of the paper we find a United Press item which promises to be a greater problem to agriculture and to agricultural engineering. It quotes the president of the National Council of Farmers' Cooperatives to the effect that farm labor is demanding $20 to $35 a day for harvesting certain crops—crops whose production is made mandatory by dire "warnings" couched in terms of labor deferment, replacements of tires and machinery, and other rationing.

If government policy toward labor racketeering is to be one of perpetual appeasement, the lust for union dues will not long overlook the farm, and it will be farms of the better managed, more-mechanized sort which first feel the pinch. Not only a realistic recognition of this trend, but a faith that the theoretical right of labor to organize could and should be put into practice in a fair and constructive fashion, leads to the following proposal.

Within the limits of their information and intelligence, the rank and file of American workmen aim to be good citizens. There must be millions who want their organizations to be something better than a cloak for crime and a rendezvous for racketeers. They should and no doubt would welcome ways whereby they can fulfill such bargains, collective or otherwise, as they may make.

Disparity in bargaining power, as between big business and little man, is reversed when it comes to agriculture. The individual farmer, chained to his chores, is in no position to argue against gat and goon. Neither is the individual farmhand in position to assert his innate decency, once he is dominated by a despotic leadership, nominally but not actually of his own choosing.

Root of the problem, and key to its solution, are inherent in the impossibility of bargaining between responsibility and irresponsibility. Employers, big or little, are responsible financially and legally. Employes, at least collectively, are not. They are provided neither the motive nor the machinery to make good when they fail to abide by a bargain. They are not permitted, much less required, to defray such damage as may come from their crimes of commission or omission. *(Continued on page 172)*

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Drying Hay With Forced Ventilation

By R. C. Miller and G. R. Shier
MEMBER A.S.A.E. — MEMBER A.S.A.E.

BECAUSE it is so easy to forget the great loss that constantly occurs in haying, it seems best, in undertaking a discussion of the results of studies made in Ohio during the past four years on the drying of partly cured hay in the mow with forced natural air ventilation, to review some of the generally recognized losses of hay from field to feed.

The hay crop, in humid areas where rain brings the necessary moisture to grow the crop, is often severely damaged, if not entirely lost, due largely to unfavorable hay-curing weather. Especially is this true of legume crops such as alfalfa, clover, and soybeans.

Frequently, as all know who have made such hay, the entire first cutting of alfalfa is almost worthless as hay. Furthermore, lateness of cutting or removal of the cut alfalfa greatly reduces the amount and quality of the next crop. It is a fair estimate that, on the average, one-half the first cutting of alfalfa hay is lost as feed. One great loss is the shattering of leaves which occurs both before and after the plant is cut; and the leaves carry 60 to 75 per cent of the total protein in hay[1]. If the cutting is delayed, the lower leaves fall off as the plant matures, and thus only a few leaves at the top of an alfalfa or soybean plant remain on the plant at the time of cutting. Then, as the plant dries to below 30 per cent moisture content, the leaves shatter in the handling processes such as tedding, raking, loading, stacking, and storing in the mow. Often only the stems with a few or no leaves are made into hay. These losses due to shattering are especially great if the field-curing process is interrupted by rains so that the hay requires extra handling, such as turning the swath or windrow.

In addition, there is the great loss of vitamins and other food values due to excess weathering by sun and rain during the curing period. Then finally, even if the hay is placed in the mow, it may be in such a moist condition that it heats and causes further losses. If the heating is excessive in some small section of the mow, spontaneous combustion may cause fire which destroys not only the crop but also grain, feed, livestock, and equipment that usually are also stored or housed in the barn. It is almost impossible to make hay by the ordinary methods without some of these losses, especially leaf shattering losses due to handling at a moisture content below 30 per cent. The hay should be dried to an average moisture content as low as 20 per cent in order to be safe from excessive heating or mold damage in storage. Such damage may result in hay containing over 25 per cent moisture.

Thus if farmers can have a practical way of eliminating or greatly reducing the losses and hazards of hay making, we will probably have attained the greatest improvement in agricultural practices in modern times.

The studies on the drying of partly cured hay in the mow with forced natural air ventilation that were made cooperatively by the research staffs of the Tennessee Valley Authority and the University of Tennessee[2] can easily stand out as one of the great research studies in agriculture for the method does provide a practical way of making hay in humid climates. The method insures high quality of hay and largely eliminates or controls the losses and hazards previously mentioned. Experience with the same method on several farms in Ohio during the past four years verifies the results.

Four barns in which this type of hay drying is installed were studied by the authors to obtain information to be used in suggesting the design and operation of such drying systems in Ohio.

The Anderson farm at Maumee, Ohio, was the first observed. The method used on this farm varied from the Tennessee studies in that the hay was chopped. The chopped hay presented some problems not common to unchopped hay[3].

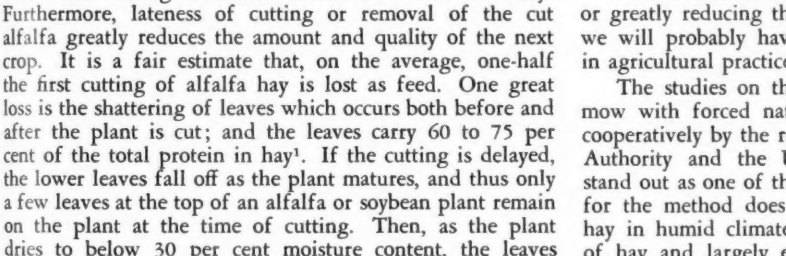
In 1940 and 1941 some observations were made on the Wood farm near London, Ohio, where all the alfalfa hay was dried by this method in a hay barn built specially for the purpose. It is 28 ft wide, by 84 ft

Paper presented December 7, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Farm Structures Division. Authors: Respectively, associate and assistant agricultural engineers, Ohio Agricultural Experiment Station.

[1]Ohio Extension Bul. 1[illegible]0. "When" and "How" in Haymaking, by R. D. Lewis and C. J. Willard.

[2]Bul. No. 170. Drying Hay in the Barn and Testing Its Feeding Value. University of Tennessee.

[3]For a summary of the studies on the Anderson farm, see AGRICULTURAL ENGINEERING for November 1942, vol. 23, no. 11, page 350.



(Left view) This shows the main air tunnel in the University of Ohio dairy barn, used in the hay drying studies. The openings in the tunnel along the floor line are for the lateral flues in the mow • (Right view) The propeller type fan used in these studies.

long, and has sidewalls 14 ft high and a gambrel roof. A total depth of about 20 ft of hay could easily be stored and dried. This gave a capacity of about 85 tons.

In 1940 the first cutting of alfalfa was almost a total loss in the London, Ohio, area due to wet weather. The cutting was delayed from about June 5 to June 20, and even then all the hay was exposed to several heavy rains over a period of more than three days before it could be stored, most of it at moisture contents that ranged from 25 to 55 per cent. Although the original plan was not to fill the mow more than 8 ft deep as recommended by the Tennessee report, the owner found it impossible to cure the balance of the crop in the field, so he decided to take the risk of filling the mow to capacity before the first layer had cured. The results showed some dusty hay, yet most of it was of good quality.

Inexperience in operating the system probably was the main cause for some mold because the fan might have been operating at times when it was left idle. The mow was emptied in time to store the second alfalfa cutting in August. Some of this cutting was placed in the mow on the afternoon of the same day that the hay was cut in the forenoon. Also, the mow was filled to a height of only about 8 ft due to smaller yield. The result was bright green-cured hay that was later ground for use in feed mixtures.

A variation in design of the Wood farm system from the Tennessee system was that the main tunnel was along the side of the mow rather than through the center. Larger and longer lateral flues were installed to compensate for change in length of flues required for a central main duct system.

A No. 8 American Blower with a high-speed, backward-curved, multivane fan driven by a general-purpose tractor, was used to provide forced air ventilation.

In 1941 a forced natural air ventilation system was installed in the hay mow of the dairy barn[4] on the Ohio State University farm at Columbus. The main difference of this installation from that used at Tennessee was in the design of the main tunnel which takes the air from the fan and delivers it to the lateral flues placed on the mow floor. The tunnel was placed at the side of the mow instead of at the center, and was much larger proportionately to the air it delivered in order to lower the velocity to about 1,000 fpm and the static pressure to 3/8 in. The tunnel was built 4 ft wide at the floor, 2 ft wide at the top, and 8 ft high. This reduction in velocity and resistance provided fairly uniform air flow through the lateral flue openings which were placed at 5-ft intervals along the main tunnel. This is simply applying the law of fluids, that is, $VP=VP$. Furthermore, the large flue at the side permits a person to walk in it to make adjustments in air deliveries to the various flues. The lateral flues opened into the main tunnel at the floor level. The size of the flue opening can easily be adjusted with a sliding board damper.

The lateral flues were made in sections about 10 ft long. The section nearest the main tunnel was about 8 in high and 16 in wide. The next section was reduced to about 12 in wide and 7 in high, and the third section was made of 1x6-in boards for sides and top. Thus the flues could be telescoped for proper adjustments. The bottom of the flues is open, having cleats 1 in thick every few feet. The cleat spaces the flue above the floor to permit the air being distributed to the hay along its entire length. (The accompanying drawing shows details of construction and installation.)

The June haying season was as bad in 1941 as in 1940. The University farm made an attempt to fill other barns with hay in the ordinary method, but adverse weather conditions finally forced the decision to place the hay in the ventilated mow. On June 20, 14 loads of hay with moisture contents varying from 28 to 44 per cent were placed in the mow, the average being 36 per cent. The next day 14 loads more were added. Their moisture content averaged 28 per cent. The 28 loads contained about 50 tons of hay with an average moisture content of 32.6 per cent. It required the removal of about 16,000 lb, or 8 tons of water, to reduce the moisture content to a 20 per cent basis. This amount of hay filled the mow to a height of about 8 ft over a floor area 84 ft long and 32 ft wide.

A 48-in six-bladed Aerovent fan driven by a 5-hp motor furnished the air. It delivered about 30,000 cfm against a pressure of about 3/8 in of water. From June 20 to July 1 the fan operated about 148 hr, or 14.8 hr per day. The power consumption was 481 kw-hr, or 3.3 kw per hr, or 4.35 hp.

Although the hay was not dry by July 1, the farm manager needed more room for damp hay, so 9 loads more of hay were added on July 1 and 6 loads more on July 2, which added about 75,000 lb, or 37 tons of hay. This hay was a mixture of wheat, timothy, alfalfa, and clover. The average moisture content was 27 per cent.

The fan was operated for about 3 weeks more, or up to July 20. The total power consumption for the 80 tons of hay was 1,833 kw-hr for the 495.5 hr the fan operated in 30 days, or 3.7 kw per hr, or 4.95 hp. The power consumption was about 23 kw-hr per ton of damp hay. The fan was operated 499.5 hr in 30 days for an average of 15 hr per day.

The study suggested that the fan might advantageously be operated continuously at times. It would also seem advisable to operate the fan on nights when the air is cool, and stop it sometimes during the day when the air is very warm and humid. The best drying with natural air is likely to take place when the air is cooler than the hay.

The hay contained only 11.5 per cent moisture in January 1942 when feeding of it began. The quality was good considering the kind of hay that was placed in the mow. There was some dusty or musty hay, especially near the top, and it must be remembered the air had to pass through about 20 ft of hay to dry the hay on top.

In 1942 a similar system was installed in the University beef cattle barn; this mow is 44 ft wide. Eighty-five feet at the west end was ventilated. The installation was similar to that in the dairy barn. The main air tunnel was constructed along the south side of the barn under the roof of a shed lean-to. This tunnel is 6 ft wide and about 8 ft high. There are fifteen lateral flues spaced about 5 ft apart. The fan is a multivane forward-curved, low speed type that had been used for ventilation in a classroom building. It delivered about 40,000 cfm of air at 1-in static pressure.

The forward-curved multivane fan, although efficient, presents a problem of power consumption in a situation where the resistance varies. The lower the resistance, the greater the power consumption. In a haymow the hay furnishes the resistance. This resistance varies as the depth of hay varies. Therefore, extra resistance had to be provided to maintain a pressure of at least 1 in so that the power consumption would be kept low enough so as not to overload the motor used.

Both barns were filled with the first cutting of alfalfa

[4]This installation and study was made in cooperation with the farm, dairy, and agronomy departments of the University. The fan was furnished by the Aerovent Fan Co., Piqua, Ohio. Material for the main tunnel lining was furnished by the Douglas Fir Plywood Assn. The University farm furnished native lumber from its wood lot for dimensional material and lateral flue material.

hay in 1942. Again, as in 1940 and 1941, rainy weather was a great handicap. It was practically impossible to make hay in June by the ordinary method. Nearly all the hay that went into both mows was placed there only after an attempt had been made to cure it for storage in other barns. Therefore, all the hay had at least one or more rains on it before it got to the mow. Much of it would have been about a total loss if we had not had the ventilated mows.

The dairy barn mow received 18 loads on June 11 and 15 loads more on June 18, or a total of about 64 tons of hay with moisture contents ranging from about 22 to 40 per cent. The mow was filled to a height of about 12 ft. About ten more tons were added on June 22. The ventilation stopped on July 3.

Hay from the second cutting was placed in the mow starting August 5. The mow was filled to capacity with hay containing about 35 per cent moisture. The fan was operated about nine days in August.

About 6 tons of a third cutting was placed in the mow on October 3. This hay contained about 35 per cent moisture. The fan again was operated about ten days. The hay was of good quality as it was fed to dairy cattle, starting about October 25.

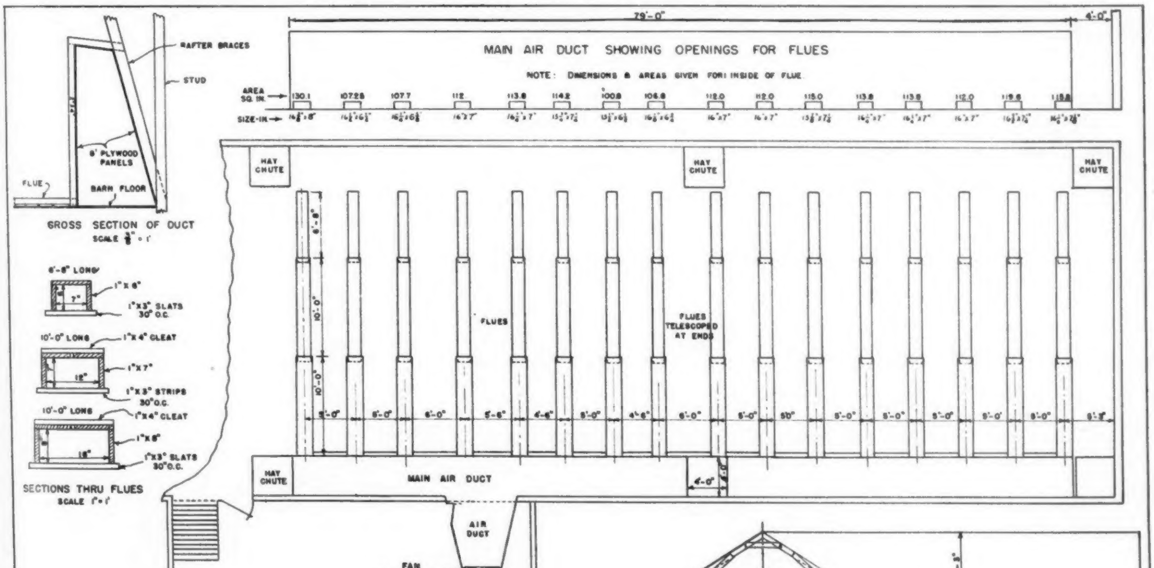
Thus about 75 tons of hay were saved in the dairy barn this year (1942). Nearly all this hay was placed in this mow because it could not be cured for baling or storage in other mows.

The beef barn received its first hay on June 14—about 20 tons. The hay averaged about 30 per cent moisture. Twenty-four tons were added on June 15, some of which contained moisture as high as 38 per cent. Eighteen tons were placed in the mow on June 19, 10 tons on June 20, 15 tons on June 22, and 18 tons on June 24, which contained only about 20 per cent moisture. Fifteen tons were added on June 25. About 5 tons of 25 per cent moisture hay were added on June 30. A final addition of 15 tons of 35 to 40 per cent moisture hay was added on July 9, which filled the mow completely, making a total depth of over 20 ft and a total of about 140 tons of hay. The fan operated until July 18 when all the hay seemed dry. The hay fed to date is of good quality.

Thus, the forced ventilation of hay in the mow cured about 200 tons this year. Most of this would have been almost a total loss without the ventilation system. In addition to saving the hay, the method received high praise from R. L. Bazler, the University farm superintendent, because it enabled him to use help much more efficiently. The crew can start earlier in the morning and work more continuously through many hours and even days when it would not be possible to make hay the ordinary way.

It must be remembered that extra good quality hay with practically no loss of leaves or color can be obtained by this method if cutting and curing time is planned carefully. Also, the farmer needs no special field equipment other than what he has used for haying by the old method.

A great satisfaction to all is the elimination of fire hazard, for the drying hay is cooler than the outside air. Finally, if the fan is operated while the hay is placed in the mow, the men usually have an air-conditioned mow where the temperature is cooler than outside air.



Details of construction and installation of equipment used in the studies of Miller and Shier at the Ohio Agricultural Experiment Station on the drying of partially cured hay in the mow with forced natural air ventilation

Unified Terracing Procedure

By J. T. Copeland
MEMBER A.S.A.E.

THE CROPPING practices, the soil, and the climatic conditions in Mississippi make it mandatory that all successful erosion control and conservation practices be compounded and used unitedly.

In the state row crops are generally planted either upon or are finally cultivated to make bedded lists elevating the seed and young plants above the water level of the row middles. These beds must be carefully laid within grade limits for both proper drainage and adequate erosion control.

There are more than 150 soil types, predominately clastic, generally acid and exceedingly erosive.

The climate contributes erosion hazards with mild winters which permit almost incessant bacterial disintegration of organic materials and with long summers with alternating drenching rains and hot desiccating extremes. These conditions interspersed with the 30 to 60 in annual precipitation, leaching, and transporting of soil elements make adequate terraces, contoured cultivation, and vegetative cover an absolute necessity.

Prior to 1940 there was no concerted united terracing action. The teachers taught, the specialists specialized, the technicians technicized, and the inspectors marveled at the many terracing conceptions and practices. The farms suffered and the farmers wondered.

Paper presented December 9, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Soil and Water Conservation Division. Author: Extension agricultural engineer, Mississippi State College.

In 1940 the conservation subcommittee of the state coordinating council, (composed of the administrative heads of the various state and federal agricultural agencies) named technical committees to work out plans and make recommendations for the various phases of conservation work. The agricultural engineering committee converted its findings into recommendations and specifications which were adopted by the council. These recommendations divided land slopes into their normal, subnormal, and abnormal groups and recommended terrace standards and mechanical treatments for the physical use of the land.

In 1941 the state coordinating council approved the engineering committee's recommendation of holding seven area terracing schools to extend these standard practices to county and district workers for their voluntary attendance. These schools met with such favor that in 1942 the council recommended that ten additional trainer schools be held with a five-day compulsory attendance for all county workers not attending and qualifying in the 1941 schools. Those attending the schools were as follows:

	1941	1942	Total
Agricultural Adjustment Administration	79	114	193
County extension agents and assistants	22	81	103
Farm Security Administration personnel	1	9	10
Soil Conservation Service men	56	56	112
Vocational agricultural teachers	3	41	44
Total	161	301	462

The trained personnel from these schools has returned to the counties and has trained *(Continued on page 148)*

Reducing Labor and Power in Soybean Production

By R. I. Shawl and A. L. Young
MEMBER A.S.A.E. MEMBER A.S.A.E.

IT IS recognized that most of the labor and power practices referred to in this paper, and employed in soybean production, have already been used by individual farmers. There may be a considerable variation in labor requirements if unfavorable weather conditions interfere with normal germination and growth: (1) If the ground stays wet for a very long period after planting, the germination of the beans may be greatly reduced, necessitating replanting. (2) If a hard surface crust forms on the ground before the seed germinates, the tender necks of the bean stems may be broken as they push through the surface, greatly reducing the stand. This crust must be broken by rotary hoeing or harrowing before the beans start to push through the ground.

Some of the following practices are standard; others offer considerable possibilities in labor and power saving. It is assumed that good seed will be sown on productive land where the season will be long enough for proper maturity and harvesting. The suggested practices are as follows.

1 *Soil Preparation.* (a) where beans are grown two years in succession, tandem disk the ground once or twice using a harrow behind the disk the last time over. (b) For beans grown after corn, plow the ground with harrow attached as late as possible before planting and tandem disk once with harrow attached.

Paper presented December 8, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Authors: Respectively, professor and associate professor of agricultural engineering, University of Illinois.

2 *Planting.* (a) Where weed infestation is light, plant beans (1) solid, traveling around the field pulling a tandem disk and grain drill or (2) in straddle rows 21 in apart with a two-row 42-in corn planter. (b) Where weed infestation is heavy enough to require cultivation, plant (1) in rows 21 or 28 in apart traveling around the field pulling a tandem disk and grain drill or special row beet and bean planter behind it, or (2) in rows around the field with a two or four-row corn planter as set for planting corn.

3 *Cultivating.* (a) Cultivate solid or straddle row planting one to three times with rotary hoe, drag harrow or weeder. (b) Cultivate rowed beans once or twice with a rotary hoe or harrow and (1) cultivate one or more times with a special tractor bean cultivator; (2) cultivate wide planter rows with regular corn cultivator.

4 *Harvesting.* (a) The combine harvester is considered the most desirable method of harvesting soybeans because it costs about one-half as much as the binder thresher method, and the grain losses are only one-third to one-half as much. The 5-ft combine is the smallest size commonly recommended for soybeans. (b) Where the binder thresher method is used, threshing should be done as soon as possible after cutting without shocking the grain. If shocked soybeans become thoroughly wet, they often rot before they can be dried out sufficiently for threshing.

5 *General Suggestions.* (a) Fields that are free from volunteer corn and large weeds allow early harvesting before a killing frost and reduce the number of stops during harvesting. If heavy weeds are left in the field, harvesting is delayed until the *(Continued on page 148)*

A Device for Plowing Under Fertilizer

By R. H. Wileman
MEMBER A.S.A.E.

THE PLACEMENT of commercial fertilizer is a subject which has received a great deal of study and experimentation. This work has resulted in the development of new types of distributors for applying relatively small amounts of fertilizer in the row without injuring seed germination. However, much still remains to be learned about the most effective methods of applying commercial fertilizers where more than a starter quantity is needed.

A new principle in fertilizer placement, namely, to apply the fertilizer deep where more than a starter quantity is needed so as to have the plant food nutrients in the moist soil where they are accessible to plant roots during periods of mild drought, was proposed and studied by Dr. Geo. D. Scarseth of Purdue University agricultural experiment station. The basic theory behind this idea is that effective heavy applications of fertilizer can be made on soils of low fertility by this method without the danger of injuring seed germination. Prior to 1940 the experiments were conducted by placing the fertilizers by hand methods. The results of these early tests were so promising that the author was asked to develop an attachment for plows which would apply the fertilizer at the same time the plowing was done. Such an attachment was designed and constructed during the winter of 1939-40 on a two-bottom 14-in tractor plow (Fig. 1).

The fertilizer hopper and feed mechanism from a commercial tractor cultivator side-dressing attachment was supported on a suitable frame on the plow. The feed mechanism drive shaft was extended to the landside of the plow and an auxiliary wheel attached to an arm which pivots around this shaft. The drivewheel runs on the unplowed land and is free to conform to the ground contour irrespective of the plow. The lower limit to which this wheel can go is controlled by a chain which raises the wheel clear of the ground when the plow is lifted, thus stopping the fertilizer mechanism. In case it is desired to use the plow and not the fertilizer attachment the drivewheel can be raised up and fastened so that it does not come in contact with the ground when the plow is operating.

The distributor drive consists of a disk gear on the drivewheel which operates a pinion on the upright shaft. This pinion is adjustable by a speed change mechanism enabling a quick change to any ratio on the disk gear. The upright shaft is connected to the distributor shaft by bevel gears which take care of the up-and-down movement of the drivewheel. This type of drive makes possible a wide selection of distributor shaft speeds and thus a wide range of rates of application which has been very desirable in conducting experimental tests. The feed gate adjustments together with the drive speed changes enables applications of from 100 to over 2500 lb of fertilizer per acre.

The most effective method of applying the fertilizer with respect to the furrow or furrow slice was under considerable question. Flexible distributing tubes were provided and arranged so that by shifting these tubes and changing the type of spreader or boot, the fertilizer could be broadcast on the surface before the furrow slice was turned, spread in the trash immediately back of the jointer, or placed in a band on the bottom of each furrow (Fig. 2). Provision was also made for shifting one of the flexible distributing tubes so that the fertilizer was all placed in one furrow. With a two-bottom plow this amounted to placing the fertilizer in every other furrow.

TABLE 1. The Effect of Applying a Balanced Mixed Fertilizer Broadcast on the Ground and Plowing It Under as Compared to Applying the Fertilizer on the Plow Sole in Every Furrow, Every Second Furrow, or Every Third Furrow on the Yields of Corn in 1941 on a Clermont Silt Loam Soil at North Vernon, Indiana. (The season was extremely droughty and water was the first limiting growth factor most of the season)

Fertilizer used, lb. per acre	Method of application	Yield, bu. per acre	Increase over untreated, bu/acre
None		23.6	
500 (8-8-8)	Broadcast, plowed under	30.2	6.6
500 (8-8-8)	On plow sole every furrow	42.7	19.1
500 (8-8-8)	On plow sole every 2nd furrow	44.2	20.6
500 (8-8-8)	On plow sole every 3rd furrow	41.3	17.7

Article prepared especially for AGRICULTURAL ENGINEERING. Journal paper No. 91 of the Purdue University Agricultural Experiment Station, and a contribution of the Department of Agricultural Engineering. Author: Assistant professor of agricultural engineering, Purdue University.

AUTHOR'S ACKNOWLEDGMENT: This development was made in cooperation with Dr. Geo. D. Scarseth, B. A. Krantz, A. J. Ohlrogge, and Harry L. Cook of the Agronomy Department who have been making an extensive study of principles of soil fertility. The results of this study are being published as a station bulletin.

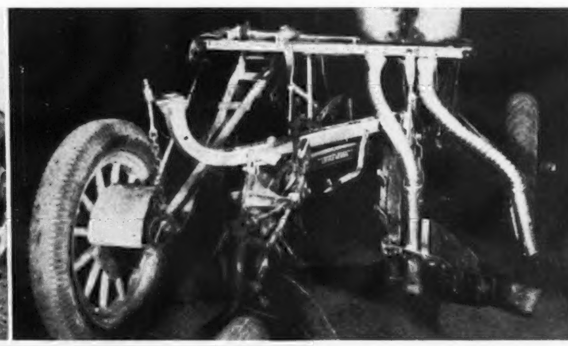


Fig. 1 (Left) Plowing under fertilizer with the original attachment during the spring of 1940. The fertilizer in this case was being spread in the trash just back of the jointers • Fig. 2 (Right) Close-up of fertilizer distributor spouts arranged for placing the fertilizer in a band on the bottom of every furrow. By shifting the front spout back with the rear one the fertilizer is placed in every other furrow

Tests conducted during the 1940, 1941, and 1942 seasons in cooperation with the Agronomy Department have shown very outstanding results from this method of fertilizer application.

The extremes in moisture conditions are represented by Tables 1, 2, and 3. The 1941 season was extremely dry at North Vernon with moisture conditions nearly normal at Reelsville. The other extreme was encountered in 1942 at Cloverdale when it was so wet that it was impossible to get into the field to plant the corn until June 3. This gives an opportunity to compare results under widely varying moisture conditions.

TABLE 2. The Effect of Applying a Balanced Mixed Fertilizer in Heavy Amounts on the Ground Surface Before Plowing and in Bands on the Plow Sole in Every Furrow and Every Second Furrow on the Yield of Corn on a Very Infertile Vigo Silt Loam Soil Near Reelsville, Indiana, in 1941.

Fertilizer used, lb. per acre	Method of application	Yield, bu. per acre	Increase over untreated, bu/acre
None		12.2	
1000 (8-8-8)	Broadcast, plowed under	56.7	44.5
1000 (8-8-8)	On plow sole every furrow	69.0	56.8
1000 (8-8-8)	On plow sole every 2nd furrow	68.5	56.3

It will be noted from the above results that significant differences are secured by the placement of the fertilizer which is plowed under, with best results being obtained where the fertilizer is placed in bands on the plow sole. For corn no significant difference between 14 and 28-in band spacing has been found. The concentration of the fertilizer in a band on the plow sole has proven better than mixing it in the trash as the furrow slice is turned and much better than broadcasting it on the surface before plowing according to these tests.

The results secured from these studies during 1940 and 1941 were so outstanding that the International Harvester Company built several attachments similar to the original described here and made them available for use during 1942.

TABLE 3. A Comparison of Various Methods of Adding Heavy Amounts of Fertilizers to Very Infertile Soil and Adding a Small Amount of Row Applied Starter Fertilizer as Related to the Yields of Corn in 1942 on Vigo Silt Loam Soil near Cloverdale, Indiana. (Rainfall was excessive in spring and early summer.)

Fertilizers, rates and methods used for heavy fertilizer applications		Bu/acre, 17.5 per cent moisture (Average of 4 replicates)	
Fertilizer used, lb. per acre	Method of application	No row fertilizer Yield corrected for frost factor†	150 lb/acre (2-12-6) row fertilizer (starter)
None		18.4	18.2
1000 (0-10-10)	On plow sole in bands 14 in apart	23.3	18.2
1000 (5-10-10)	On plow sole in bands 14 in apart	39.7	39.7
1000 (10-10-10)	On plow sole in bands 14 in apart	45.1	54.0
1000 (10-10-10)	Broadcast on surface and plowed under	37.2	45.7
1000 (15-10-10)	On plow sole in bands 14 in apart	43.8	55.7
1000 (15-15-15)	On plow sole in bands 14 in apart	56.6	69.7
500 (10-10-10)	On plow sole in bands 14 in apart	32.6	37.2
500 (10-10-10)	On plow sole in bands 28 in apart	31.0	38.9
500 (10-10-10)	Broadcast on surface and plowed under	23.7	21.0
*500 (10-10-10)	Broadcast after plowing; disked in	15.0	16.4
*500 (10-10-10)	Applied in row		30.9
0	150 lb. (0-12-6) applied in row		20.6

*Weeds were especially troublesome on these plots.

†Corn was planted late (June 3) and killed by frost very early (Sept. 24). The average date of the first killing frost in the fall is about Oct. 15. The corn with starter (row) fertilizer did not quite mature, and the corn without starter fertilizer lacked even more of maturing as shown by the fact that at frost it contained at least 8 per cent more moisture than the corn with starter fertilizer. Using unpublished data of S. R. Miles, Agronomy Department, Purdue University, the yields from treatments without starter fertilizer were adjusted so that the differences due to starter are very probably more nearly what they would have been if frost had held off until all corn was mature.

The tests conducted during 1942 were on a much larger scale since more equipment was available for applying fertilizers with plows. The results of these tests were just as favorable as in previous years, which has resulted in a demand for the attachments many times in excess of the company's ability to supply them due to the shortage of materials.

The outstanding results secured thus far by this method of applying commercial fertilizers and the interest shown by farmers in it may radically change the method of fertilizing several of our most important crops as soon as the equipment can be made available.

Unified Terracing Procedure

(Continued from page 146)

785 committeemen and custom-terrace-line service men to qualify for state approval and county service.

The state engineering committee prepares and issues instructional material, terracing specifications, examination questions, and terracing certificates. The trained county personnel and the county coordinated council conduct county and community training schools and promote the county terracing and conservation program in line with their interpretation of the county needs. Counties having the minimum service of the various agencies are conducting only terracing schools to train local and community line servicemen to meet the farm demand for terraces.

In the counties with complete service of the five agricultural agencies, exemplary advancement is being made with a correlated and unified terracing program with each agency representative working in harmony with each other agency representative, and at the same time performing the regular functions for his agency.

In a typical county the county coordinating council has worked out the general policy, has received the approval of the state coordinating council, and has provided personal and community terracing and water disposal service. The respective personnel take assignments of responsibility in line with the particular duties of the agency represented—to the point that general, supervisory, technical, and inspection service is rendered to communities with farm agreements for land use, conservation treatment, terrace-line-service inspection for terrace construction and terrace inspection, either for contractual or for farmer construction with or without grant-of-aid compliance payments.

Soybean Production

(Continued from page 146)

weeds are killed by frost. (b) Roguing or weeding the fields is done with hand labor and with the least effort while the beans are still small enough to walk through. (c) There are usually less weeds in soybean fields if the ground is plowed late, disked and planted immediately. The usual plan is to plow early and disk anywhere from three to five times to kill the seeds before planting. (d) Where beans follow beans there are fewer weeds when the ground is tandem disked only and not plowed. (e) If the tractor has sufficient power to pull both the tandem disk and drill much time is saved and no ground will have to be redisked in case of rain. When the disk and drill are used together, the ground is not harrowed after planting. (f) Planting in regular corn widths 38 to 42 in tends to reduce the yields somewhat and may allow the beans to fall over on the ground thus increasing losses at harvesting time. In row planting the rows must be spaced to accommodate the tractor wheels and the width of the cultivator and the combine cutter bar.

Reducing Labor and Power in Cotton Production

By H. P. Smith

COTTON is one of the field crops that has not been entirely mechanized. Thinning and harvesting are the two missing mechanical links. These two operations require large amounts of hand labor in the spring for thinning and in the late summer and fall for harvesting. Other operations such as plowing, planting, cultivating, and controlling of insects, require considerable labor and power. Heavy demands on the nation's labor supply, much of which is needed in the production of vital war materials, emphasizes the importance of economizing in the use of labor[2]* and power in the production of cotton by:

1 The use of larger units and the performance of two or more operations at the same time

2 Mechanical thinning, hill dropping of mechanically delinted seed, and planting thin

3 The treating of planting seed to obtain better stands, thus reducing replanting operations

4 Shallow cultivation.

5 The use of mechanical harvesting equipment.

Labor and power requirements in the production of cotton are influenced by the topography of the land, soil types, and climatic factors, such as rainfall and temperature[2]. Fewer man hours, machinery hours, and tractor hours are required on large level farms in the low rainfall areas than on the small, hilly farms traversed by numerous terraces and where abundant rainfall causes rapid growth of grass and weeds. More power is required to till the heavy clay soils than the lighter sandy soils..

The Use of Larger Units and Performance of Two or More Operations at the Same Time. The differences in labor and power requirements for different areas is definitely substantiated in a recent study by Czarowitz[3] of the cost of producing cotton in five areas of Texas. The study included widely separated areas of different topography, soil types, rainfall, and farming conditions.

Paper presented December 8, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Author: Chief, division of agricultural engineering, Texas Agricultural Experiment Station.

*Superscript numbers indicate the references appended to this article.

Planting cotton with four-row tractor equipment

Table 1 shows the preharvest labor required to produce cotton amounts to 5.5 hr per acre in the high plains, 8.8 hr in the rolling plains, 25 hr in the black prairie, and 50 hr in the northeast sandy lands. The differences in labor requirements for the different areas is more clearly seen in Table 2 which shows the amount of labor required to produce a 500-lb bale of cotton. The preharvest labor per bale in northeast Texas is eleven times and the total labor is four to five times the preharvest and total labor in the high plains. These differences in labor requirements show the influence of type and size of equipment used in the different areas.

The small farm of east Texas and most of the cottonbelt usually has poor soils which requires applications of fertilizer to obtain worth-while yields[1]. As a general rule application of fertilizer is a separate operation from the preparation of the seedbed or planting. Labor and power requirements could be materially reduced in these areas by planting and applying fertilizer at the same time.

Mechanical Thinning, Hill Dropping of Mechanically Delinted Seed, and Planting Thin. One of the greatest labor consumers of cotton production is that of thinning or spacing the plants, commonly called "chopping" throughout the cotton belt. At the time the cotton is thinned it is also hoed. The labor required to thin and remove the grass and weeds is clearly reflected in the amount of preharvest labor of the Northeast sandy lands area as compared to that of the plains area.

Due to labor shortage many cotton farmers last spring used mechanical thinners and were quite satisfied with the results.

TABLE 1. LABOR REQUIREMENTS PER ACRE IN THE PRODUCTION OF COTTON*

Area	Most common size or type of power unit	HOURS LABOR SEEDBED PREPARATION TO HARVESTING: Seedbed preparation	Planting	Cultivating	Hoeing chopping	Total preharvest labor	Harvesting	Total all labor	Approx. ave. annual rain fall, in	Normal yields, pounds lint†
High plains cotton	2-row tractor	0.7	0.5	1.4	2.9	5.5	14.7	20.2	20	185
Rolling plains	2-row tractor	1.3	0.7	1.3	5.4	8.8	16.2	25.0	25	135
Black prairie	1-row tractor	5.8	1.8	6.8	10.4	25.0	24.0	49.0	35	170
Northeast sandy lands	1-row and part-row horse	10.0	3.5	18.0	18.5	50.0	26.5	76.5	45	150

*From Texas Agr. Exp. Sta. Bul. 624 and Prog. Rept. 682.
†Five-year average as determined by Agr. Adj. Adm.

Planters equipped with hill dropping attachments that will accurately drop from four to six seeds per hill would save much preharvest labor in many areas. If cottonseed were partially mechanically delinted, the planter dropping mechanisms and hill dropping devices would function more accurately and smoothly and a definite number of seed could be dropped per hill.

TABLE 2. LABOR REQUIREMENTS PER BALE IN THE PRODUCTION OF COTTON*

Area	Hours labor required per 500-lb bale: Preharvest labor	Total labor
High plains cotton	14.2	52.1
Rolling plains	31.1	88.4
Black prairie	70.2	137.7
Northeast Texas sandy lands	159.6	244.0

*From Texas Agr. Exp. Sta. Bul. 624 and Prog. Rept. 682

Cotton farmers of Northwest Texas and Western Oklahoma plant cottonseed comparatively thin and as a general rule do not bother to space or reduce the stand of plants by thinning. This practice materially reduces preharvest labor.

Treating of Planting Seed to Obtain Better Stands. It is not uncommon to hear cotton farmers say that they had to replant two or three times before they obtained a satisfactory stand of cotton. Each replanting requires as much labor and power as the first planting and substantially increases the cost of producing the crop.

Experiments definitely show that the treatment of cottonseed with Ceresan prior to planting increases stands of seedlings[4, 5].

It appears from observation that many cotton farmers run their cultivator sweeps so deep that the operation is practically equivalent to a thorough plowing of the soil. Deep cultivation near the young cotton plants no doubt gives them a severe root pruning. This deep cultivation consumes much power, reduces the rate of travel, and in general increases the amount of labor required.

The entire cotton crop of the nation — yes, of the world—is harvested by hand. Harvesting is so slow and tedious that more man hours are required for the harvest than any other operation performed in producing the crop. In fact, in the plains areas of Texas and Oklahoma more than twice as much labor is expended in harvesting as is done prior to harvest. In the black prairie area preharvest labor amounted to 25 hr per acre while the harvest required 24 hr of labor[2, 3]. In the northeast sandy lands where more cultivation and hoeing was necessary preharvest labor amounted to 50 hr per acre while the harvest required 26.5 hr per acre as compared to 14.7 hr per acre in the high plains and 16.2 hr per acre in the rolling plains area. A suitable mechanical harvester in the plains areas would reduce almost by one-half the total labor to produce a crop.

In these areas a simple, cheap stripper type machine can be used satisfactorily. In other sections where the plants grow larger and the harvest is earlier a picker type machine would probably be more suitable[6].

It is recognized that all farmers producing cotton cannot make use of all of these suggestions, but most farmers can by careful study and planning materially reduce their labor and power requirements in the production of cotton.

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Trends in Hay Curing and Storage

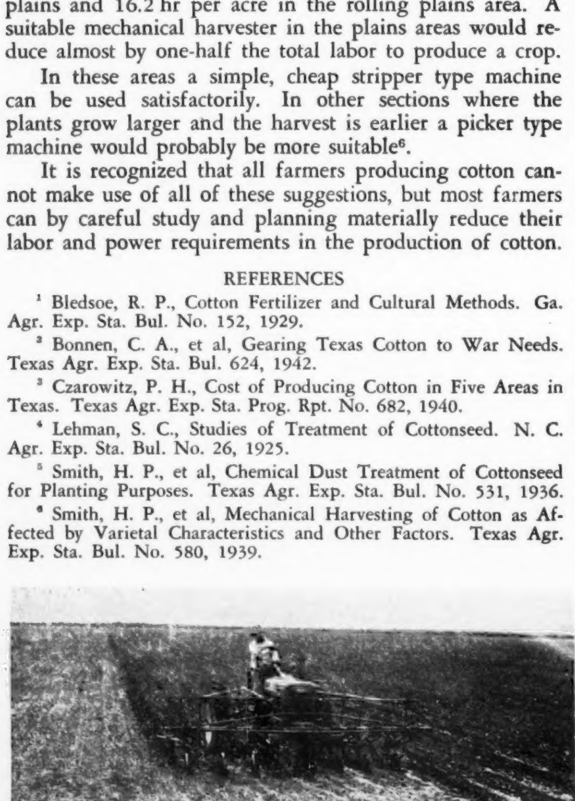
By G. R. Shier
MEMBER A.S.A.E.

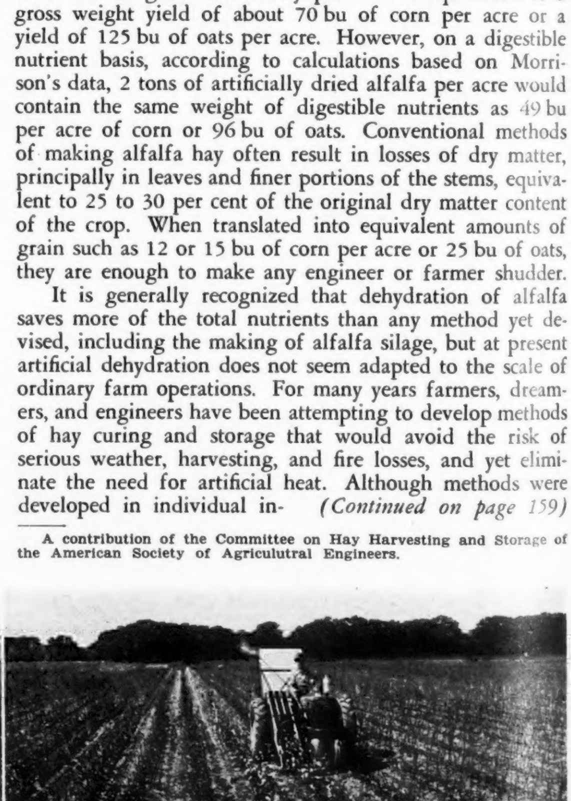
IN REPORTS to the A.S.A.E. committee on Hay Harvesting and Storage compiled in 1942, considerable confusion was apparent in regard to the trends in processing and storing hay. Although several fine pieces of research have been carried out in the hay storage area, it was evident that much remains to be done. Hay is not a product like apples, potatoes, or grain, which must be stored in such a manner that relatively high quality is preserved in order to have a usable product. Aside from the considerable amounts of leaves and stems lost in harvesting, hay can be weathered or heated and still retain much of its calorie value as a feed. Morrison notes a decline of 7.8 per cent in the total digestible nutrients between dehydrated hay and brown hay.

Almost any kind of hay that is palatable to livestock still retains a large amount of nutrients, and consequently our hay harvesting and storage problems are thus complicated by the fact that the introduction of methods to preserve quality in hay must be based principally on practices that will either prevent the total loss of the crop from weathering or the loss in handling of important percentages of dry matter as well as the retention of substances which are the base for vitamin formation or retention. A yield of 2 tons of good alfalfa hay per acre is equivalent to a gross weight yield of about 70 bu of corn per acre or a yield of 125 bu of oats per acre. However, on a digestible nutrient basis, according to calculations based on Morrison's data, 2 tons of artificially dried alfalfa per acre would contain the same weight of digestible nutrients as 49 bu per acre of corn or 96 bu of oats. Conventional methods of making alfalfa hay often result in losses of dry matter, principally in leaves and finer portions of the stems, equivalent to 25 to 30 per cent of the original dry matter content of the crop. When translated into equivalent amounts of grain such as 12 or 15 bu of corn per acre or 25 bu of oats, they are enough to make any engineer or farmer shudder.

It is generally recognized that dehydration of alfalfa saves more of the total nutrients than any method yet devised, including the making of alfalfa silage, but at present artificial dehydration does not seem adapted to the scale of ordinary farm operations. For many years farmers, dreamers, and engineers have been attempting to develop methods of hay curing and storage that would avoid the risk of serious weather, harvesting, and fire losses, and yet eliminate the need for artificial heat. Although methods were developed in individual in- *(Continued on page 159)*

A contribution of the Committee on Hay Harvesting and Storage of the American Society of Agriculutral Engineers.





(Left) Cultivating with four-row tractor equipment saves labor and power in the production of cotton. (Right) Harvesting cotton with a harvester developed by agricultural engineers of the Texas Agricultural Experiment Station

Overturning Resistance of Wood Fence Posts

By Henry Giese

FELLOW A.S.A.E.

FENCES of some sort have been employed by man for many centuries for protection and for confinement of livestock. The agricultural production program of a large portion of our country could scarcely be maintained without fencing of some kind.

In 1916 Humphrey[12]* expressed rather forcibly the magnitude and acuteness of the problem of securing adequate fencing. "The enormous proportions which the farm-fence problem has assumed to the farmers of the United States can best be shown by the use of figures given in the reports of the last census, combined with data obtained in the studies of this office. In 1909 there were 6,361,502 farms in the United States, averaging 138.1 acres each. It has been found that the average 140-acre farm requires 6 rods of fence to the acre, or a total of 828.6 rods to the farm. This would mean that there were, in round numbers, 5,271,000,000 rods, or 16,472,000 miles, of fence in the United States in 1910. This amount of fence would encircle the earth about 659 times. To replace this with only a medium grade of woven-wire fence, a type which has been very commonly used by American farmers in the past, would cost, at the rate of 65c per rod for wire, posts, miscellaneous materials, and labor, $3,428,241,362, which is 8.3 per cent of the total value of all farm property, 12 per cent of the value of all farm land, 54.1 per cent of the value of farm buildings, 69.5 per cent of the value of domestic animals, poultry, and bees on farms, and more than double the value of all implements and machinery on farms, according to the values estimated for these items by the last census. It must be borne in mind, however, that the figures represent the first cost of fences, while the census figures represent the present value of buildings and machinery. Therefore, the ratio will not be quite as great."

Again, in 1929, the problems of fencing were given prominence in a paper by Lyman[14] presented to a meeting of the American Society of Agricultural Engineers:

"It seems that fencing has seldom been regarded as a subject or problem of sufficient importance to warrant any considerable study on the part of agricultural research agencies, be they engineering or economic in character. When fence has been thought of, it has been to wonder how we might get along with less or do away with it entirely. It has taken its place in the minds of the farmer, the teacher, and the research man similar to that occupied by sugar and flour in the mind of a grocer; a staple, necessary commodity but nothing to get enthused over. Yet fence is almost as basic as the soil itself in most of our systems of farming and over the major part of our productive agricultural area. To the structures man fence is of great importance, for without fence there is but little need for the income-producing portion of farm structures. The magnitude of the fence problem at present is spotlighted by the fact that from 25 to 50 per cent of existing fences, averaging around 30 per cent the country over, are entirely inadequate to turn livestock."

With the increasing practice of contour farming, the problem of fencing is becoming more important. This is brought out by an editorial which appeared in AGRICULTURAL ENGINEERING in 1935[4].

"Taking the country as a whole, it seems sure that no other part of the farm plant is so far gone into disrepair and disorganization. It seems equally obvious, in general, that few structural improvements are so quickly self-liquidating.

"While there are piecemeal contributions to sundry detailed phases of farm fencing, there is no orderly literature covering the subject in a way both comprehensive and soundly technical. No one can, with any assurance, define what is an optimum fence for a stated situation. Fencing evidently is a vernacular art not well organized empirically, much less engineered on a foundation of basic studies. As such an art it has been more efficient than could be expected —another testimonial to the judgment and resourcefulness of

Article prepared especially for AGRICULTURAL ENGINEERING. Journal Paper No. J-1097 of the Iowa Agricultural Experiment Station, Project 618, in cooperation with The Farm Fencing Association. Author: Professor of agricultural engineering, Iowa State College.

*Superscript numbers indicate the bibliography appended to this article.

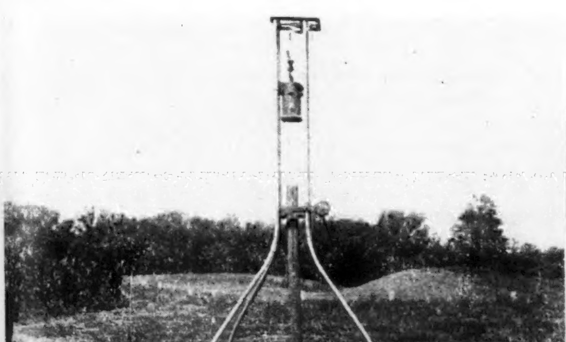


Fig. 1 (Left) The energy required to drive posts was measured by means of this device • Fig. 2 (Right) The devices used for applying loads and recording post movement in the studies by the Iowa Agricultural Experiment Station

the American farmer. Terracing and other phases of soil conservation, and indeed all land use progress, create new need for fencing or need for new fencing."

After an extensive survey of fencing practices, Kelley[13] states: "The size of wood posts varies considerably with the strength and durability of the species used. Line posts of Osage orange are sometimes as small as 2½ in in diameter. With other woods line posts are commonly 4, 5, or 6 in, and corner posts and gateposts 8 to 12 in in diameter. The least dimension for split posts is usually not less than 5 in. Large posts usually last longer than smaller posts of the same wood.

"Posts usually are set 2½ ft in the ground and extend about 6 in above the top wire. The over-all length, of course, depends on the height of the fence but is generally 7, 7½, or 8 ft for line posts, while gateposts and brace posts are of sufficient length to meet the service required."

These practices undoubtedly provide a surplus of material necessary only to assure sufficient strength after years of reduction in strength resulting from decay.

The development of preserving methods has made possible a reduction in the size of the commercial wood post. However, since definite design data for these posts are still lacking, no criteria are now available for establishing minimum sizes.

Little data are available concerning the behaviour of fence posts set in soil. Large power and communication companies, recognizing the importance of having definite design data for setting transmission poles, have made numerous investigations. Seiler[11] makes the following statement: "For any pole of a certain strength and set in a given soil, there is a depth of embedment such that its strength will be just developed. If the depth is less than that, money is uselessly spent for a post whose strength can not be utilized. If the depth is too great, there is a waste of labor in excavating the hole for the pole. Considering the many uncertainties in the action of the soil, conditions which may cause wide variations in the capacity of a given soil, and other factors, it would be ridiculous to assume that any great accuracy could be secured in the attempt to determine a precise depth of set. However, even an approach to the correct or ideal depth would, without doubt, result in important economies to large consumers of poles."

Mr. Seiler concluded that the diameter of a pole has little effect upon the stability of the pole, but that the stability varies as the square of the depth of embedment.

Another article by R. W. Abbett[1] contains the following information:

1 When a cantilever pole in compacted sandy soil rotates due to a horizontal force near its upper end, the pole rotates about a center between two-thirds and three-fourths of the depth of embedment below the surface of the ground. The point of rotation moves up as the pole continues to overturn.

2 When the pole overturns, a cone-shaped mass of soil is pushed out of the ground behind the pole. The resistance to rotation comprises the forces of friction and cohesion acting on the surface of the cone.

3 The resisting moment may be expressed by the equation

$$M = \frac{ecd^4\,(10k^2 - 15k + 6)}{30k}, \text{ or } M = Cd^4$$

in which

e = deflection of pole at surface of the ground
C = coefficient of resistance of the soil

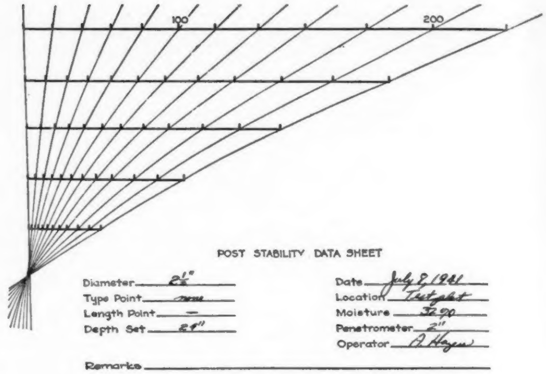


Fig. 3 A typical post stability data sheet

d = depth of embedment
k = ratio of the distance from the surface of the ground to the point of rotation to the depth of embedment of the pole.

4 Two constants must be known to determine the stability of a pole. One is the safe or allowable rotation of the pole, e, and the other is the coefficient of resistance of the soil, C.

One of the major reasons for the lack of adequate fencing on the farms of America today is the labor involved in constructing it properly.

Because the winter season was unsuitable for field work, preliminary tests of driving and overturning resistance were made in the laboratory. Laboratory tests offer some advantage in eliminating certain variables which occur in field operations. These were valuable in planning and executing field tests later.

Since much of the equipment was designed especially for the work at hand, a detailed description of each piece follows:

Post Movement Recorder. Experience from earlier work indicated the importance of taking readings at a number of points along the post to make possible the measuring of any bending which might take place in the post itself. It is also very important to make observations quickly. Not only is time a factor in any individual test, but it is also essential to complete a series before significant climatic changes affecting the soil can take place.

For this reason a special device was constructed by means of which instantaneous readings can be taken at the ground line and four positions above at one-foot intervals.

The angle iron framework is bolted to permit changes. The plywood recording board is mounted to permit movement in a vertical direction and hinged to allow the board to swing horizontally. This board is held in place during a test by a small latch on the frame. A vertical movement is utilized to make interruptions at various load increments in the horizontal progress of each recording pencil, and is obtained by a manually operated lever arrangement.

Data sheets are punched to accommodate pins fastened to the recording board, and clamped under a bar to prevent movement during a test.

Notches in the frame one inch apart hold the pencil bars in place. The rectangular bars can slide horizontally but cannot twist or move vertically. Special plungers and small rubber bands force the leads against the recording board. A brass binding post on the end of each pencil bar permits individual setting of each pencil to any position on the recording sheet.

Five piano wires transmit the movements of the points on the post being tested from the follow rods to the pencil bars. Changes in direction of motion are accomplished by passing the wires over small brass pulleys. A two-pound weight is fastened on one end and a ¼-in follow rod on the opposite end of each wire. The weights keep equal tension on each wire, and provide the force necessary for pulling the pencil across the recording sheet and keeping the follow rod against a nail driven into the post.

The follow rods are spaced 12 in apart. A maximum movement of 10 in can be recorded. A bolt attached to each leg of the recorder and resting against a small steel plate on the ground provides adjustment of the instrument to irregularities in the ground surface.

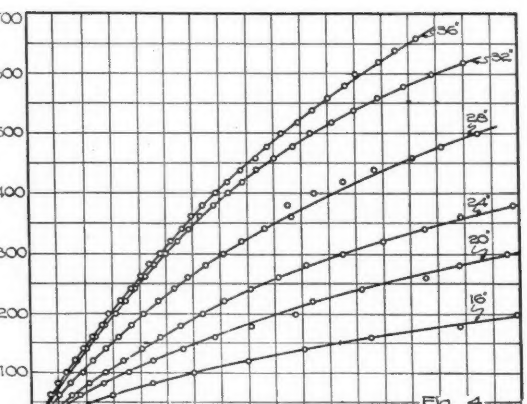
Dynamometer. The dynamometer designed for loads up to 1,000 lb consists of a frame supporting a ball-bearing pulley, a weight basket, a rope attachment between the dynamometer and the post to be tested, and a number of weights. A piece of pointed 1x1x⅛-in angle iron about 6 in long welded to the bearing plate prevents any forward slipping of the device. Lead weights of 10 and 20 lb were used. Pull is accomplished by weights in the basket.

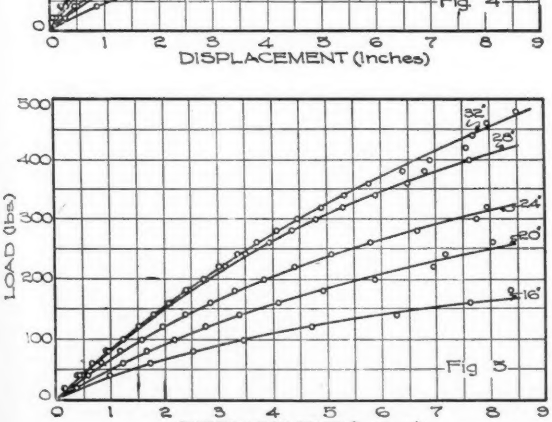
Wood Posts. The yellow pine wood posts used in the field tests were turned to uniform diameters of 2½, 3, 3½, and 4 in, respectively. The posts varied in length from 6 ft 6 in to 8 ft 0 in.

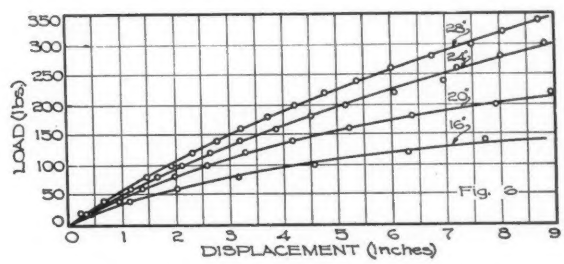
Augers. In general, fence posts are set in the ground either by removing an excess of soil in preparing the holes and replacing a portion around the posts with a tamping bar or by driving them into the soil. Since one of the main factors which might be expected to influence the stability of a post is the density or compactness of the soil in which it is set, and since it would be difficult to maintain a constant density in the soil around a post if the soil were disturbed, the method of setting posts by digging a hole larger than the post was discarded in these tests. Driving the test posts was considered, but again it would be difficult to maintain the same soil density, and also the effect of the shape or size of a point on the stability of the post is not known. Therefore, it was decided that the best method of setting the test posts to obtain data relative to the effect of diameter and depth of set upon the overturning resistance of the posts would be to bore each hole the same diameter as the post to be tested in it.

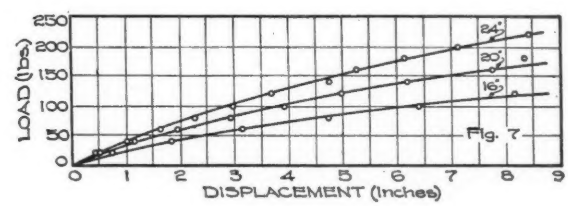
Soil. The analysis of the soil used in the test as given below was determined by the method outlined by Hogentogler[10]. This method consists of a mechanical sieving of the soil combined with a hydrometer analysis. The equipment used in the hydrometer analysis developed by Dr. G. J. Bouyoucos utilizes the varying speed of settling of particles suspended in water.

Test Plot. The test plot consisted of a clay loam layer of soil to a depth of about 29 in. Below this a thin layer of yellow clay was found, and at a depth of 34 to 36 in a gravelly, sandy clay was encountered. Since the major portion of the testing was conducted in the layer of clay loam, a laboratory analysis of this soil was made. The sample for this analysis was taken at a depth of six inches. Properties of the soil determined in this analysis are as follows: Hygroscopic moisture content, 7.80 per cent;









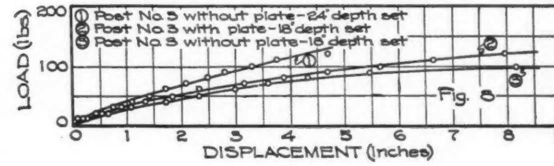


Fig. 4 Effect of depth of set on overturning resistance of wood post, 4-in diameter • Fig. 5 Effect of depth of set on overturning resistance of wood post, 3½-in diameter • Fig. 6 Effect of depth of set on overturning resistance of wood post, 3-in diameter • Fig. 7 Effect of depth of set on overturning resistance of wood post, 2½-in diameter • Fig. 8 Relation between load and displacement for steel post

liquid limit, 52.75 per cent; plastic limit, 31.87 per cent; plastic index, 20.88 per cent.

Hogentogler makes this statement about the soil used in the field tests: "A clay loam is a fine-textured soil which breaks into clods or lumps which are hard when dry. When the moist soil is pinched between the thumb and finger, it will form a thin ribbon which will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cast which will bear much handling. When kneaded in the hand it does not crumble readily but tends to work into a heavy, compact mass."

Tests of Overturning Resistance. The structural properties of soil are not easily determined and will vary greatly with compactness and moisture content. For this reason, field tests were made in an effort to determine some of the specific relations between a wood post and the soil in which it is set.

A complete series comprising six depths for the 4-in post, five depths for the 3½-in post, four depths for the 3-in post, and two depths for the 2½-in post were set and tested in one day. Ten series of this type were made for the wood posts.

Care was exercised to prepare each hole in the same manner, and to prevent the holes from drying out before being used. Accurate holes can be bored for small diameter posts successfully and at a time comparable with that required for driving wood posts. The lapse of time between increments of loads is a factor which must be considered. In these tests a period of 8 to 10 sec was allowed between load increments. At the beginning of a test this is more than sufficient for the post to come to a stationary position. As the load increases, however, 10 sec is not long enough for the post to come to complete rest. All loads were applied to the posts 50 in above the surface of the ground.

While the deflections recorded are full size, the spacing between the lines of movement on the data sheet are greatly reduced. A reduction of a typical chart and the approximate points of rotation of the post below the surface of the ground are shown in Fig. 3.

Soil moisture determinations made daily on samples obtained at a depth of 16 in below the surface of the ground varied from 26.7 to 34 per cent. This variation was not uniform from beginning to end due to intermittent rainfall.

The data taken from 180 tests conducted with the 2½, 3, 3½, and 4-in posts are presented in the form of graphs. The curves show displacement of a point 48 in above the ground surface and hence include both the movement through the soil and bending in the post.

The series of load displacement curves show the effect of depth of set upon the overturning resistance of the four different diameter posts tested. Each point on the curves represents an average of ten tests.

TABLE 1. POINTS OF ROTATION FOR WOOD POSTS
(INCHES BELOW GROUND SURFACE)

Depth set,	Post diameter, in			
in	2.5	3.0	3.5	4
16	8.72	8.93	8.61	8.61
20	11.47	12.60	12.01	10.62
24	12.10	16.98	18.11	15.21
28		15.69	18.87	15.09
32			18.47	17.17
36				21.42

The points below the surface of the ground about which each post rotated during the tests are presented in Table 1. These points were determined by bending a full-length strip of wood to conform to the coordinates obtained from the record sheets. Each value listed represents an average of ten tests.

The points of rotation of a post below the surface of the ground move downward to a maximum value, and then move upward. This maximum value is approximately one-half the depth of set.

In the type of soil used for the field tests the strength of a 2½-in post is developed at a set between 24 and 28 in. The strength of the 3-in post is developed at a set between 28 and 32 in.

In general, for soil as used in this test, and under moisture conditions experienced, a balance between post strength and soil resistance is reached when the depth of set is approximately ten times the diameter of the post.

Interpretation of these data in terms of fence construction must await determination of standards of performance (duty) and also behaviour in other soil types and under different conditions of soil moisture. The duty of a fence has not been fixed. It varies with the type of fence whether lot or field and to a degree according to the ideas of the owner.

The extensive use of steel posts implies satisfactory performance. When judged by the structural performance of steel posts, wood posts have been larger than necessary when new. This extra allowance for decay need not be provided if posts are properly treated.

The use of smaller posts will save wood, treating materials, transportation, and labor in setting.

The setting of small diameter posts turned or otherwise formed to uniform size can be greatly facilitated by the use of augers or by driving.

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Effect on Infiltration of Surface Mulches of Soybean Residues, Corn Stover, and Wheat Straw

By E. H. Kidder, R. S. Stauffer, and C. A. Van Doren
MEMBER A.S.A.E.

IT HAS been shown by research workers[1,2]* that various amounts of crop residues used on soils as a surface mulch greatly increase the amount of infiltration and reduce runoff and soil losses. In Illinois the use of crop residues offers much promise in reducing runoff and soil losses from large acreages of cultivated land subject to wind and water erosion. In some areas where most of the surface soil has been removed, mulch farming may prove to be the most desirable system to follow if these soils are to continue to produce cultivated crops. In sandy areas where damage by wind erosion has been severe soil moisture has been one of the limiting factors in crop production. Increased infiltration on these soils may be helpful in increasing the supply of moisture available for crops and also in reducing the hazard of soil movement by water as well as by wind.

The study reported in this paper was designed to determine the effect of soybean straw, corn stover, and wheat straw on the rate of infiltration of a drift soil similar to Saybrook silt loam. By means of a Type F infiltrometer, a series of infiltration determinations were made during the early growing season, after crop harvest, and in the spring of the following year prior to preparing the soil for the succeeding crop. The data from only the first, or what is commonly called the initial runs, are reported in this paper.

Paper presented December 8, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. Authors: Respectively, assistant hydraulic engineer, Office of Research (SCS), U. S. Department of Agriculture; cooperative agent, assistant professor of soil physics, Illinois Agricultural Experiment Station; soil conservationist, Office of Research (SCS), USDA.

AUTHORS' NOTE: This study is being conducted as a cooperative project between the Illinois Agricultural Experiment Station and the Soil Conservation Service (Office of Research), U. S. Department of Agriculture.

*Superscript numbers indicate the references appended to this paper.

The authors believe that a single run will more truly represent the most frequently occurring natural situations than a second run on the same soil one day later. During the initial runs the time during which water was applied and the rates of infiltration varied greatly with cover conditions. Consequently there was considerable variation from plot to plot in the degree to which the subsurface layers were wetted. The results of a run made the following day on the same areas would undoubtedly be affected by this condition.

PROCEDURE

Soil. This study is being conducted on a permeable, prairie soil with a 4 per cent slope on the animal husbandry farm of the Illinois Agricultural Experiment Station (Fig. 1). The soil is located in a morainal area of the Early Wisconsin Glaciation and is typical of a large acreage of soils in east central Illinois. A type name has not been given to this soil, but it is similar to Saybrook silt loam except that it is leached of carbonates to a greater depth than Saybrook usually is. The surface soil which varies from 7 to 10 in in thickness is a friable, granular, brown silt loam. The subsurface soil is also silt loam and is a little lighter in color than the surface. The subsoil, encountered at a depth of from 20 to 22 in, is a yellowish brown clay loam with a small amount of grayish brown mottling. The whole profile shows evidence of good subsurface drainage. The till, which is a sandy, pebbly, permeable material, occurs at a depth of 35 to 45 in on most plots. There are small areas of a few square feet in extent on two plots where the depth to till is only 24 in. It appears that the results secured in the study were not affected by this soil condition.

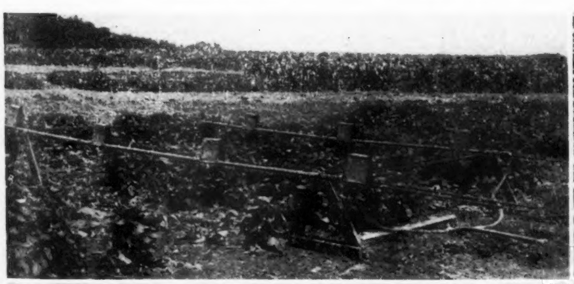


Fig. 1 (Upper left) Type F infiltrometer unit with nozzles removed used on 12x6-ft plots • Fig 2 (Lower left) General view of the slope where crop residue investigations were conducted. The tent which covers the Type F infiltrometer unit is moved over the various plots for application of rainfall • Fig. 3 (Right) Plot surfaces protected with crop residues: (Top) Corn stover, Plot 6, Block 2, before initial run (April 1942). (Bottom) Soybean residue, Plot 3, Block 3, during initial run April 1942). Note the water storage in large ponds.

TABLE 1. RATE OF INFILTRATION* IN INCHES PER HOUR FROM ARTIFICIALLY APPLIED RAINFALL FROM VARIOUS COVER CONDITIONS WITH EXISTING SEASONAL SOIL MOISTURE CONDITIONS†, ‡

Crop and Cover**	Block No.	June 1941 Length of run min	June 15 min	June 30 min	June 60 min	June 120 min	June 180 min	June 240 min	June Final	October 1941 Length of run min	Oct. 15 min	Oct. 30 min	Oct. 60 min	Oct. 120 min	Oct. 180 min	Oct. 240 min	Oct. Final	April 1942 Length of run min	Apr. 15 min	Apr. 30 min	Apr. 60 min	Apr. 120 min	Apr. 180 min	Apr. 240 min	Apr. Final
Soybeans, bare	1	69	0.53††	0.33	0.23				0.23	89	0.23	0.13	0.06				0.05	321	0.59	0.33	0.17	0.09	0.08	0.08	0.08
	2	241	1.49	1.32	0.98	0.78	0.73	0.68	0.68	140	1.33	0.58	0.30	0.20			0.20	102	0.13	0.03	0.00				0.00
	3	78	0.50	0.41	0.41				0.41	72	0.23	0.09	0.08				0.08	128	0.98	0.23	0.03	0.00			0.00
	4	228	1.55	1.36	1.03	0.76	0.56		0.48	80	0.38	0.25	0.13				0.10								
	Average		1.02	0.86	0.66						0.54	0.26	0.14						0.57	0.20	0.07				
Soybeans, wheat straw	1	246	1.75	1.75	1.75	1.70	1.70	1.70	1.70	339	1.58	1.58	1.58	1.49	1.45	1.40	1.11	480	1.73	1.73	1.73	1.73	1.73	1.73	1.17
	2	120	1.61	1.59	1.59	1.59			1.59	240	1.70	1.69	1.68	1.66	1.66	1.66	1.66	390	1.75	1.73	1.70	1.68	1.67	1.67	1.59
	3	295	1.53	1.49	1.41	1.30	1.25	1.16	1.12	300	1.67	1.66	1.63	1.51	1.33	1,12	1.11	243	1.74	1.72	1.71	1.64	1.51	1.36	1.36
	4	221	1.66	1.59	1.51	1.39	1.20		1.18	288	1.69	1.69	1.67	1.56	1.43	1.35	1.26	434	1.65	1.65	1.64	1.56	1.44	1.37	1.21
	Average		1.64	1.61	1.57	1.50					1.66	1.66	1.64	1.56	1.47	1.38			1.72	1.71	1.70	1.65	1.59	1.53	
Soybean residue	1									178	0.94	0.61	0.47	0.37			0.32	272	1.64	0.87	0.51	0.28	0.24	0.17	0.17
	2									284	1.40	0.91	0.62	0.42	0.33	0.28	0.27	362	1.65	1.32	0.72	0.39	0.39	0.24	0.24
	3									146	1.19	0.67	0.40	0.25			0.25	184	1.73	1.40	0.83	0.22	0.20		0.20
	4									174	1.35	0.75	0.44	0.25			0.21	203	1.69	1.57	1.06	0.62	0.48		0.47
	Average										1.22	0.74	0.48	0.32					1.68	1.29	0.78	0.38	0.33		
Corn bare	1	101	1.19	0.57	0.33				0.21	72	0.15	0.04	0.03				0.03	242	0.44	0.32	0.17	0.14	0.09	0.06	0.06
	2	149	1.32	0.96	0.52	0.40			0.36	74	0.11	0.07	0.06				0.06	91	0.09	0.07	0.01				0.00
	3	79	0.39	0.25	0.17				0.00	106	0.29	0.15	0.11				0.09	93	0.95	0.19	0.00				0.00
	4	227	1.48	1.29	0.84	0.55	0.41		0.37	90	0.14	0.04	0.02				0.00								
	Average		1.10	0.77	0.47						0.17	0.08	0.06						0.49	0.19	0.06				
Corn, wheat straw	1	324	1.75	1.75	1.75	1.75	1.67	1.65	1.54	190	1.70	1.68	1.67	1.63	1.62	1.61††	1.62	463	1.73	1.69	1.57	1.14	0.95	0.72	0.36
	2	155	1.77	1.76	1.76	1.69			1.60	306	1.64	1.55	1.40	1.00	0.83	0.74	0.66	315	1.70	1.68	1.59	0.93	0.74	0.62	0.56
	3	300	1.74	1.69	1.67	1.61	1.54	1.48	1.42	350	1.65	1.63	1.51	1.23	1.03	0.89	0.74	245	1.77	1.77	1.61	1.09	0.92	0.81	0.81
	4	270	1.69	1.62	1.40	1.20	1.05	0.99	0.98	224	1.63	1.15	0.81	0.54	0.40	0.34††	0.36	387	1.74	1.74	1.50	0.90	0.66	0.54	0.40
	Average		1.74	1.71	1.65	1.56					1.66	1.50	1.35	1.10	0.97	0.89††			1.74	1.72	1.57	1.02	0.82	0.68	
Corn stover	1									164	1.57	1.55	1.44	1.28			1.21	365	1.60	1.54	1.44	1.26	1.08	0.92	0.81
	2									242	1.57	1.49	1.28	1.08	1.02	0.97	0.97	364	1.59	1.57	1.46	0.94	0.73	0.71	0.55
	3									230	1.43	1.37	1.23	1.06	0.96		0.91	358	1.69	1.61	1.55	1.01	0.78	0.66	0.54
	4									292	1.43	1.26	1.13	0.93	0.85	0.71	0.64	357	1.66	1.57	1.42	1.26	1.12	1.03	0.94
	Average										1.50	1.42	1.27	1.09					1.64	1.57	1.47	1.12	0.93	0.83	

*Rate of rainfall in inches minus rate of runoff in inches.

†Prairie soil—Saybrook Silt Loam.

††Estimated.

‡Infiltration rate is expressed as an instantaneous rate in inches per hour at the specified time.

**The bare and residue plots were clean tilled. Regular farm tillage implements were used.

Equipment. The rain simulator used in this study was developed by the Soil Conservation Service and is known as the Type F infiltrometer (Fig 1). Two parallel spray heads were spaced 9.5 ft apart and 2 ft above the ground. The spray heads were located in the border area parallel to the longer axis of the plot. Four nozzles were mounted in one line and three in the other at intervals of 30 in. The nozzles were inclined inward toward the plot at an angle of 7 deg from the vertical. When the unit is operated at a pressure of 35 lb per sq in the spray from the nozzles is projected upward to a height of 6 to 8 ft and arches over the plot. The drops produced by the nozzles were fairly large, fell with considerable impact on the surface of the soil, and were satisfactorily distributed. Constant water pressure for operating the unit was maintained by a centrifugal pump. A trailer-type tent was placed over the whole unit to prevent conditions such as wind and natural rainfall from disturbing the rainfall pattern (Fig. 2).

The plots, which were 6 by 12 ft, were surrounded by sheet metal walls. These walls were 6 in wide and were driven into the soil to a depth of approximately 5 in. A collecting trough was placed at the lower end of the plot which drained into a sump where the runoff from the plot was collected in buckets.

Operation of Equipment. Two steps are involved in the operation of the equipment: (1) the adjustment of the equipment to give the desired rainfall intensity, and (2) the application of rainfall to the plot and measurement of the rate of runoff during the test. To secure the desired rainfall intensity a calibration pan was placed over the plot preceding each run. The nozzles were then uncovered and the runoff from the pan, which was 100 per cent of the amount of water applied, was measured. After the necessary adjustments in water pressure and inclination of nozzles were made, the pan was removed. At the end of a test the calibration pan was again placed over the plot and the rainfall intensity measured. The average of these two calibrations, which were usually very close, was used as the rate of application of rainfall for that run.

At the start of a run all nozzles were uncovered simultaneously with the starting of a stop watch and all recordings of time made during the run were made relative to this starting time. After the runoff started, continuous samples were collected in buckets and the net weights determined for time intervals of 1 to 10 min depending on the rate of runoff. The application of water was continued until the rate of runoff was reasonably constant for at least 30 min. At the end of a run the nozzles were covered and the residual runoff collected at one-minute intervals until the runoff ceased.

Water was applied at the rate of 1.75 in per hr. Rainfall of this intensity is not un-

usual in this area. According to Yarnell's[4] rainfall intensity-frequency data as interpolated for Urbana, a rain of this intensity may be expected more often than once in two years for the 15 and 30-min periods, and once in four years for the 60-min period.

Soil samples for moisture determinations were taken in triplicate in the border area prior to starting the initial run. These samples were taken with a soil auger by 10-in increments to a depth of 40 in.

Plot Arrangement and Treatment. Four contour base lines were laid out on a 4 per cent slope at a minimum interval of 50 ft. A block consisting of six square plots, each 24.75 ft on a side, was located on the upper side of each base line. The plots were located at random in each block.

The crop and plot treatments on each of the six plots in each block were as follows:

Plot No.	Crop	Treatment	Residue
1	Soybeans	Clean tilled	None
2	Soybeans	Subsurface tilled	Wheat straw
3	Soybeans	Clean tilled	Soybean residue
4	Corn	Clean tilled	None
5	Corn	Subsurface tilled	Wheat straw
6	Corn	Clean tilled	Corn stover

Artificial rainfall was applied to the plots in June, October, and April. In June 1941, there were four conditions on each block of plots. Soybeans were growing on Plots 1 and 3 without mulch and on Plot 2 with a wheat straw mulch applied after seeding at a rate of 2 tons per acre. Corn was growing on Plots 4 and 6 without mulch and on Plot 5 with a wheat straw mulch applied after planting at a rate of 2 tons per acre. In October 1941, when the second set of infiltrometer runs were made, six conditions existed. The soybeans on Plots 1 and 2 had been removed for hay. The surface of Plot 2 was still protected by the remains of the straw mulch applied just after planting. The soybean seed had been harvested from Plot 3 and the residue scattered on the surface of the plot, simulating a field harvested by a combine (Fig. 3 lower view). The corn including the stalks had been removed from Plots 4 and 5. The wheat straw, applied in May, remained on Plot 5. The corn on Plot 6 had been husked and the stalks broken over to the ground parallel to the contour row. This condition simulated a corn field harvested with a corn picker, except that instead of the stalks being broken over at a point approximately 15 in above the ground, they were broken at the surface (Fig. 3 upper view). Suitable attachments on a corn picker would accomplish similar results. If it is desired to do mulch farming where corn borer control is necessary, low cutting and shredding equipment might be attached to the corn picker.

The cover conditions for the April 1942 runs were essentially the same as for those of October 1941, except for some disintegration of the mulches during the winter.

DISCUSSION OF RESULTS

For the purposes of this discussion the rate of infiltration will be considered as equivalent to the rate of rainfall minus the rate of runoff. Infiltration rates arrived at by this method will not be entirely correct for those periods in which surface storage is building up rapidly. For the unmulched plots the largest error will occur during the first fifteen minutes of the run. Surface storage builds up much more slowly on the mulched plots.

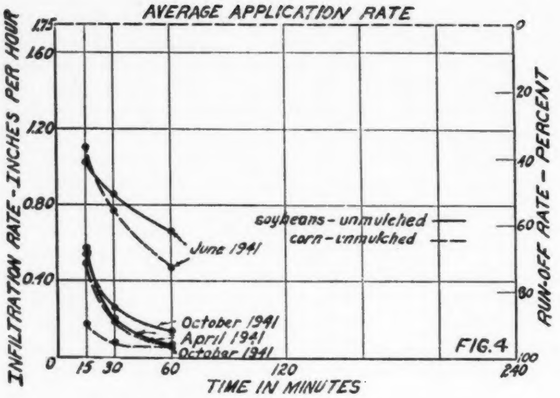
June Tests. Rates of infiltration in inches per hour at specified times from unmulched plots of soybeans and corn, and from plots of soybeans and corn which were mulched with wheat straw, are recorded in Table 1. Rain simulator tests were not made in June on the corn and soybean plots which were to have the residues returned as a mulch after harvest. When artificial rain was applied to unmulched soybean and corn plots, the rate of infiltration decreased rapidly (Fig. 4). At the end of 60 min the average rate of infiltration for the unmulched soybean plots had fallen to 0.66 in per hr. The rate of runoff was 62 per cent of the rate of rainfall. At the end of the same period, the average infiltration rate on the unmulched corn plots was 0.47 in per hr with a corresponding rate of runoff of 73 per cent. At the end of 60 min, the rates of infiltration in June on unmulched plots were from four to eight times as great as those in October. Two factors were effective in causing most of this difference. First, the ground had been prepared for planting of corn and soybeans two weeks prior to the start of the runs in June; hence the plowed layer was not as compact in June as in October. Second, the canopy of the growing crop furnished some protection to the soil in June, while the only canopy furnished in October and April was the crop stubble.

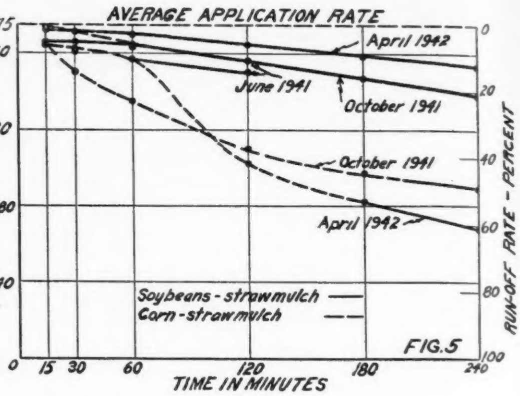
The decrease in the rate of infiltration was more gradual on the soybean and corn plots that had been mulched with two tons of wheat straw per acre than on the unmulched plots (Figs. 4 and 5). The average rate of infiltration for the straw-mulched soybean plots was 1.57 in per hr at the end of one hour and 1.50 in per hr at the end of two hours. The average infiltration rate on the straw-mulched corn plots was 1.65 and 1.56 in per hr, respectively, for the same periods.

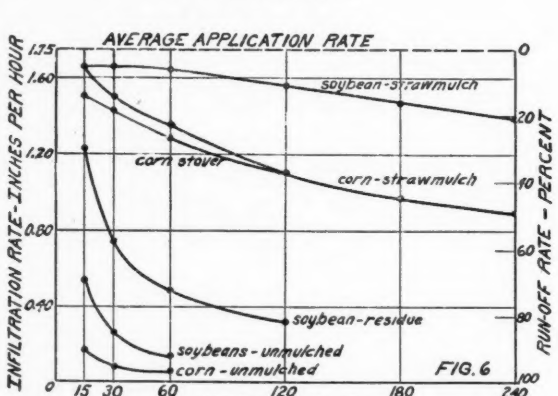
October Tests. In October, soybeans and corn had been harvested. Soybean hay and corn fodder were removed from the unmulched and from the wheat straw-mulched plots. Soybean residues and corn stover were returned to the plots which were to be mulched after harvest.

Rates of infiltration in inches per hour from all plots in October are recorded in Table 1. The average rate of infiltration on the unmulched corn and soybean plots decreased more rapidly in October than in June (Fig 4). At the end of 60 min the average rate of infiltration on the soybean plots was 0.14 in per hr. At the end of the same period the rate of infiltration on the corn plots was 0.06 in per hr. In October, the surface was essentially bare as little protection was offered by the standing crop stubble. An examination of the surface layer of soil from these plots indicated that the surface had been compacted and the pores of the soil clogged with fine silt particles. This compaction and clogging results from the impact and dispersing action of the raindrops on the unprotected surface[3]. Over 65 per cent of the water applied to the unmulched plots was running off the plots at the end of 15 min. It can be concluded that the percentage rate and total volume of runoff from unprotected soil surfaces will be high for those natural storms in which there is a 15 or 30-min period early in the storm with rainfall intensity similar to the intensity used in this study.

The average rate of infiltration decreased more gradually on the soybean and corn plots that had been mulched with 2 tons of wheat straw per acre than on the unmulched plots (Fig. 6). At the end of four hours on the straw-mulched plots the rate of infiltration for the soybean plots was 1.38 in per hr, and for the corn plots was 0.89 in per hr. The rate of runoff at the end of four hours was 20 per cent from the straw-mulched soybean plots and 53 per cent from the straw-mulched corn plots. Observations made on the surface under the straw mulch indicated that the mulch had protected the soil from the packing and dispersing action of the raindrops. The great differences that exist between the infiltration rates on the straw-mulched plots as compared to the unmulched plots can be attributed in a large







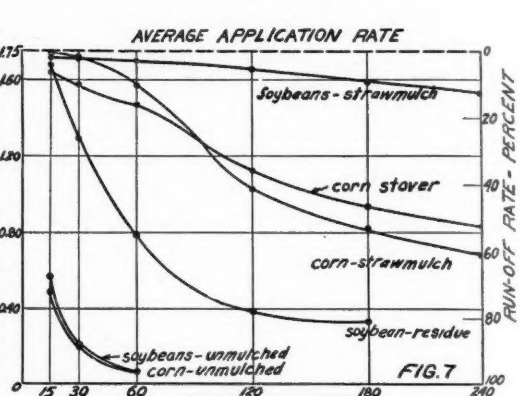


Fig. 4 Average rates of infiltration and average rates of runoff at different seasons from clean-tilled soybean and clean-tilled corn plots. Figures plotted are average values from quadruplicate plots, except in April 1942 when the tests were made in triplicate (1941-1942) • Fig. 5 Average rates of infiltration and average rates of runoff from soybean and corn plots with surface mulched with straw. Figures plotted were average values of quadruplicate tests made in June and October 1941 and in April 1942 • Fig. 6 Average rates of infiltration and average rates of runoff from corn and soybean plots with exposed surfaces and with various mulches. In all cases the plotted figures are average values from quadruplicated plots (October 1942) • Fig. 7 Average rates of infiltration and average rates of runoff from corn and soybeans with different mulches. Figures plotted are average values from quadruplicate tests, except from the bare plots which were made in triplicate (April 1942)

degree to the protection which the mulch gives to the surface.

In October the surface soil of the corn plots was more compact than the surface soil of the soybean plots. This was very evident when taking soil samples for volume weight determination. It was considerably more difficult to force the small volume weight cans into the soil of the corn plots than into that of the soybean plots. This difference in the degree of compactness is apparently one of the causes of the greater infiltration on the straw-mulched soybean plots than on the straw-mulched corn plots. Volume weight and aggregate analysis determinations made on samples of soil from these two series of plots, however, did not show consistent differences.

Corn stover was more effective in increasing infiltration and decreasing runoff than soybean residue even though greater infiltration was secured on soybean as compared to corn plots when the surface was unmulched or when protected with wheat straw mulch. The cornstalks and leaves provided a greater volume of mulching material than the soybean residues, and they covered a greater percentage of the soil surface. Another explanation of the increased infiltration from plots with corn stover as compared with soybean residues was the placement of the cornstalks. The stalks were broken down on the contour encouraging formation of large ponds that protected the surface from the direct impact of the rain drops. The average rate of infiltration for corn stover plots was 1.27 in per hr at the end of 60 min, and 1.09 in per hr at the end of 120 min (Fig. 6). The runoff rates were 27 and 38 per cent respectively.

The average rate of infiltration for soybean residue plots was 0.48 in per hr at the end of 60 min and 0.32 in per hr at 120 min (Fig. 6.) Infiltration runs made in the fall of 1940 on soybean plots on which the residues had been returned gave much higher rates of infiltration than the runs made in October, 1941. In 1940 the infiltration rate was 1.47 in per hr at the end of 60 min and 1.10 in per hr at the end of 120 min. In 1940 the soil surface was more uniformly covered with leaves than in 1941. One test run was made in 1940 on a plot from which the leaves were removed, and only the stems and pods returned. The infiltration rate on this plot was 1.18 in per hr less at the end of 60 min than the rate for the plots from which the leaves were not removed. Adverse climatic conditions prevented replication.

Soybean residue was not as effective as wheat straw in maintaining high rates of infiltration, but corn stover probably was. The soybean residue did not cover the surface as completely as wheat straw or as corn stover. Under the soybean residue a greater portion of the surface of the soil was exposed and subjected to the direct impact and puddling action of the raindrops.

April Tests. A third series of runs was made on these plots during April and May, 1942, with the same cover

conditions as existed in October. During April, free water was at times within 20 in of the surface. The average rate of infiltration for the unmulched soybean plots was 0.07 in per hr at the end of 60 min, while the rate for the unmulched corn plots was 0.06 in (Fig. 7). The necessity of preparing the plots for the succeeding crops made it desirable to reduce the number of replicates from four to three for the unmulched surface conditions for this series of tests. The average rate of infiltration at the end of two hours for the straw-mulched plots on which soybeans had been grown was 1.65 in per hr while that for corn was 1.02 in. At the end of the same period the rate was 0.38 in per hr for the soybean residue plots and 1.12 in per hr for the plots mulched with corn stover.

Mass Infiltration. Mass infiltration obtained from the various crop and cover conditions supports the facts reported on rates of infiltration during the June, October, and April tests. The average mass infiltrations for the first 60-min periods are reported in Table 2. Greater infiltration occurred on the unmulched plots in June than in October and April. As previously explained, this was mostly a result of canopy and soil conditions. Mass infiltration was greater on the plots which were mulched with wheat straw than on the unmulched, the soybean residue, or stover-mulched plots. The stover-mulched corn plots had a higher mass infiltration than the soybean residue plots.

TABLE 2. AVERAGE MASS INFILTRATION* IN FIRST 60 MINUTES AS INFLUENCED BY SURFACE COVER† - URBANA, ILLINOIS

Crop and cover‡	Mass infiltration, in (60 min) June 1941	October 1941	April 1942
Soybeans:			
Bare	0.91	0.47	0.47
Wheat straw mulch	1.66	1.68	1.71
Residues	——	0.93	1.28
Corn:			
Bare	.88	0.23	0.39
Wheat straw mulch	1.70	1.56	1.68
Stover	——	1.44	1.49

*Mass infiltration refers to the total quantity of water absorbed during a 60-min period.

†Each figure is an average of four replicates, except for the bare plots in April when only three replicates were run.

‡The bare and residue plots were clean tilled. Regular farm tillage implements were used.

The importance of providing mulches to increase infiltration is emphasized by supplementary data which show greater soil losses from the plots which have low infiltration than from those plots with high infiltration. For example, the calculated soil loss in October from the plots with corn stover mulch was 351 lb per acre, while that from the unmulched corn plots was 4199 lb per acre for the first 60-min period. The average mass infiltration on these plots was 1.44 in on the corn stover plots and 0.23 in on the unmulched corn plots.

The value of any mulch for increasing the amount of infiltration depends mainly on how effectively the residue prevents compaction and sealing of the pores of the surface soil. Borst[1] has shown that applications of two tons of straw per acre effectively cover and protect the surface, while one ton allows some sealing to take place with consequent reduction in infiltration and hence greater water loss. The volume of water that drains from the plot at the end of a run, commonly known as residual runoff, definitely indicates that the thickness of the detention film is greater on the mulched plots than on the unmulched plots. The numerous obstructions to flow offered by the residue create small ponds which serve to increase the depth of the boundary layer thus keeping the high velocities away from the plot surface.

SUMMARY

A study was made on a permeable prairie soil with 4 per cent slope to determine the effect of the use of wheat straw, soybean residue, and corn stover on infiltration during the early growing season, after harvest, and in the spring of the following year.

Artificial rainfall was applied to quadruplicate plots 12 ft by 6 ft in size. Rainfall was applied at an intensity of 1.75 in per hr until the rate of infiltration remained reasonably constant for a minimum of 30 min.

For this discussion the rate of infiltration was considered equivalent to the rate of rainfall minus the rate of runoff.

The rates of infiltration on unmulched soybean and corn plots in June were from four to eight times as great as in October. In June the rates of infiltration decreased more rapidly and were finally maintained at a lower level on the unmulched plots than on plots which were mulched with two tons of wheat straw per acre.

In October soybean residues and corn stover were returned to those plots which were to be mulched after harvest. Corn stover was more effective in increasing infiltration and decreasing runoff in October and April than soybean residue even though greater infiltration was secured on soybean as compared to corn plots when the surface was unmulched or when protected with wheat straw mulch.

The rate of infiltration at the beginning of a run was often in excess of 1.00 in per hr. This rate decreased rapidly during the first 15 min of the run on the unmulched plots. Application of artificial rain to unmulched soil causes the pores at the surface to seal, resulting in a high percentage of water loss and considerable erosion. Straw mulches and corn and soybean residues, by protecting the surface soil and creating ponds, greatly reduce the amount of surface area that is sealed by the dispersive action of the raindrops. A deeper boundary film of water on the mulched as contrasted to the unmulched plots caused the high velocity currents to move at a greater distance from the ground surface.

With the wartime demand for increased acreages of grain crops, the necessity of keeping the residues on the land cannot be overemphasized. The practice of commercially disposing of crop residues such as corn stover and grain straw is increasing the erosion hazard on sloping fields, by allowing increased runoff and resulting increases in soil loss.

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Trends in Hay Curing and Storage

(Continued from page 150)

stances, they never became widespread due to the excessive space, equipment, or labor required. It remained for Tennessee Valley Authority and the University of Tennessee to devise and push the barn curing method that has real promise of reducing weather, harvesting, and fire losses, that retains quality, and that does not require excessive labor, power, and equipment. Reports to the Committee indicated that of all the newer developments in hay curing and storage the mow curing of hay with forced ventilation was receiving the most attention.

Producing Hay with Less Labor and Power

By Leonard A. Brandrup
MEMBER A.S.A.E.

IN THE production of hay it is often difficult to utilize fully the existing machinery in a given area, even of small size, due to crop conditions, management factors, and, not the least by any means, human factors. There are five things I would suggest for better utilization of labor and power in hay production; they are:

1 Keep existing equipment in good repair
2 Interest local agencies in assisting with the training of people who must operate and repair equipment
3 Raise maximum yields of hay
4 Plan for the extended use and duty of existing machines in areas of machine shortage
5 Meet the lack of adequate up-to-date machinery by the use of homemade equipment.

To secure maximum production with reduced man power and machinery and at the lowest possible cost will require the practicing of all five of the above-listed factors.

Maintenance of Equipment. It is a known fact that much haying equipment is operated under conditions below a reasonable standard of maintenance. These conditions become progressively worse after the first season's use. Many hours are lost yearly due to the fact that mower cutterbars are not kept in proper shape; knife heads break because crankpin bearings or pitman straps are run with too much play; rake bearings wear out; loader chains break in the field, and conveyor chains of pickup balers are jammed into the baling chamber.

Much of this trouble could be avoided by thorough maintenance before the working season begins. Such maintenance is not generally had because the farmer either feels he does not have time to check the machine, or because he trusts to luck that the thing will hold out another season. I know from complaint analyses that a good deal of time lost in the field is due to machinery on a below par maintenance level. Using mowers as an example, it would not be difficult to find many sections throughout the Middle West where you could go from farm to farm and discover machines which need only thirty minutes attention to the cutterbar and perhaps a dollar's worth of repairs. This repair work would prevent much aggravation and loss of time in the field.

Training for Equipment Operation and Repair. Since many experienced men are leaving farms and repair shops to join the armed forces or are entering war industries, it is now our job as agricultural engineers to assist in training people who are left to operate and repair farm equipment. It is true that various agencies have spent time and effort instructing farmers and dealers in keeping machinery in repair but much more will need to be done along this line.

The full effect of the existing drastically reduced program of new farm equipment will only be felt toward the end of the next harvesting season when a certain percentage of older equipment will fail and require extensive repair. There are instances where it is rather doubtful whether in the final analysis anything is gained by keeping a machine going which normally would have been scrapped. A breakdown in the field does not only cause loss of precious man-hours, but often entails serious weather hazard and damage to a crop.

I would suggest that this group give serious study to the problems of a thoroughgoing maintenance plan if the severe restrictions on new farm equipment now in force should have to be continued beyond the 1943 production season. The thought behind this suggestion is that many farmers will have neither time nor tools nor experience to recondition wornout machinery effectively and that the educational efforts of colleges, extension services, and vocational farm advisers will not be enough to prevent a farm machinery crisis if under the weight of a prolonged war present equipment restrictions have to remain in force for more than the next year.

To Raise Maximum Yields. One of the most important factors in reducing labor and power requirements in the production of hay is to raise maximum yields per acre. For example, with the proper fertilization, liming, and management alfalfa yields may be increased at least 50 per cent.[1] Other than the cost of handling this increased yield the labor requirements, the power requirements, and the equipment expenses are the same for large yields as for small yields. Since the raising of hay will need to be increased on the farm to meet the greater demands for livestock production, a reduction in man power in relation to the crop produced will become more and more essential with the curtailment of labor on the farm.

Extended Duty of Machines. Many machines for the production of hay, especially those used on the smaller farms, could be used many more hours during the year than is now the case. Then too through more effective management many operators could more nearly obtain the maximum daily performance of a machine particularly where it is being used in conjunction with one or more machines. Good management may result in as much as 50 per cent more capacity calculated on the basis of width and operating speed. The extended use of machines through rental or custom work should do much to reduce the power requirements and man hours especially in areas where there is a lack of adequate equipment. Just what the practical duty of a machine should be depends on factors such as weather, size of the farm, topography, and management, but an analysis made at the Iowa Agricultural Experiment Station by E. G. McKibben indicates that it is both feasible and economically possible to expect 150 to 200 per cent of the average annual use of most machines as operated on farms in Iowa in 1941.

Homemade Equipment. Faced with a serious shortage of labor and in some areas by an insufficient number of hay tools, many farmers will have to think of some equipment that can be made on the farm and which will save work at haying time. The buck rake can be cited as an example, for it is something that can be built by the farmer himself or by a blacksmith or in a welding shop. It can be mounted on an old automobile chassis or on a rubber mounted tractor. The metal material used in its construction would consist in the main of second-hand material available on the average farm, and the wood could be bought at a local lumber yard. Although the homemade buck rake will enable many farmers to put up their crop, it will not likely be the solution of hay harvesting in the future. However, it will fit into the present machinery setup and will enable many farmers with inadequate help or equipment to put up their crops for a reasonable cash outlay.

A program looking to the saving of labor and power not only in the production of hay but in all farm crops is a problem of engineering at all times and this is especially true in wartime. It is the duty of every engineer to be of special service to his country in this vital war program.

A buck rake mounted on a farm tractor

Paper presented December 8, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Author: Service manager, New Idea, Inc.

Producing Flax with Less Labor and Power

By A. J. Schwantes
FELLOW A.S.A.E.

MOST OF the flax grown in this country is raised in Minnesota, North Dakota, South Dakota, Iowa, Wisconsin, Kansas, Texas, and California. In 1942 Minnesota's flax acreage was 1,726,000 which was 37 per cent of the total in the United States.

Because the flax stem does not grow leafy and bushy like that of wheat, oats, and barley, it does not shade the ground so well and hence is a less successful competitor of weeds than are the cereals. One of the most important factors in the successful production of flax is that of preventing weed growth in the flax field.

When considering possibilities of reducing labor and power expenditures in the production of flax, or any crop, it is important that essential requirements be met and the quality of the work be such that the crop does not suffer materially. It is conceivable that a saving of 10 or 15 per cent in man-hours per acre brought about by the elimination, or less thorough performance, of some operation might result in a reduction in yield such that the labor and power expenditure per unit of crop would actually be increased. An operator without sufficient power and labor for his acreage might better reduce the acreage to the point where it can be well cared for.

The most effective way of dealing with a bad situation is to prevent it, if possible. The care and effort necessary to insure seed that is as free as possible from weed seeds and small pieces of straw that carry disease spores is certainly of first importance and probably will result in subsequent savings of power and labor many times as great as the cost of providing clean seed. The importance of cleaning flax for seed is further emphasized by the amount of dockage it commonly contains.

The seeds of many common weeds such as mustard, false flax, and yellow foxtail are so near the size of flax that separation is difficult. Because the flax seed is small the capacity of a sieve in terms of bushels per hour is also comparatively small. To do effective separation the seeds must pass over the sieve in a thin layer so all of the seeds in the mixture, small enough to pass through the screen openings will have opportunity to do so.

Brookins[1] recommends the use of a combination outfit consisting of a fanning mill and a disk type separator. The fanning mill should be equipped with two scalping sieves and corrugated cylindrical sieves for final screening. The flax mixture is first run over the fanning mill and that portion retained in the cylindrical sieves is then run through the disk separator. This outfit will produce, at a reasonable rate, seed that is quite uniform in size and relatively free from weed seeds.

In 56 trials comparing the yield from seed cleaned with the combination cleaner with that from the same seed cleaned with a farm fanning mill, the average yield from the former was 0.98 bu per acre higher than that from the latter. The use of a combination fanning mill and disk cleaner or other type of commercial cleaner requires less labor than a farm fanning mill and better results are obtained.

In farm management studies in Nicollet County, Minnesota, in 1941 reported by Engene and others[2], is included the following comparison on nineteen farms of labor and power requirements per acre of flax for all field work up to harvest:

	Lowest per acre costs	Highest per acre costs
Number of farms	10	9
Man-hours per acre	2.6	3.6
Horse hours per acre	2.1	4.5
Tractor hours per acre	2.1	2.4

Paper presented December 8, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Paper No. 473 Miscellaneous Journal Series, Minnesota Agricultural Experiment Station.

Author: Professor of agricultural engineering, University of Minnesota.

[1]Brookins, W. W., agronomist, Central Fibre Corporation.

[2]Engene, S. A. and others. A Preliminary Report of the Farm Accounting Route in Nicollet County, Minnesota. Mimeographed Report No. 131, Division of agricultural economics, University of Minnesota.

These data obtained by one field man during a single season in the same locality indicate the tremendous difference between individual farmers in power and labor expenditures for seedbed preparation and planting. It is impossible to isolate all of the factors contributing to this difference. Examination of the data in detail indicate that they are of three types: (1) Efficiency or managerial ability of the operator, (2) character of the facilities such as size of fields and size of power unit, (3) practices followed, namely, number and kind of operations performed. The order in which these are listed represents also their relative importance so far as their influence in placing a particular operator in a high cost or low cost class is concerned.

The personal factor is one with respect to which changes are most difficult. It is natural that some farmers are able to manage better and produce more efficiently than others.

The size of fields is important in economical use of labor and power. Its importance increases with an increase in the potential capacity of the machine units. Anderson[3] arranged field machines into three groups representing potential capacities as follows: Group I, 3 to 5 acres per hour; group II, 1 to 2 acres per hour; group III, ½ to 1 acres per hour. In his studies of the performance of machines on fields of various sizes he found that machines in group I will increase significantly in efficiency (acres per hour) as the size of field increases up to about 20 acres. There are only slight increases for fields larger than 20 acres. For machines in group II the smallest optimum size of field is about 14 acres, and for those in group III it is about 10 acres. For all machines the efficiency reduces rapidly with fields smaller than 8 acres. While size of fields cannot be increased on some farms, improvement in this respect offers possibility for considerable increase in field operating efficiency. In fact, a study of possible field rearrangement would probably be worth while on many farms.

The effect of potential capacity of the power unit, as influenced by both size and speed, on labor efficiency is obvious. The size of the power unit is limited by the size of farm, size of fields and amount of work to be done annually. This factor can be taken care of only when a new tractor is purchased and should be given careful consideration at that time. When the cost of labor is high, it is possible to justify a larger and more expensive unit than when the cost of labor is low. A power unit, regardless of size, will produce lowest cost power when it is loaded to its optimum capacity. The possibilities of increasing speed are definitely limited by the optimum speed for performing various tillage operations. In so far as it is consistent with allowable investment in machinery, the machine unit should be sufficiently large to fit the tractor. Sometimes two operations may be performed simultaneously.

In the farm management report referred to above[3] are included the following data comparing the labor requirement for various operations performed with tractors with that when horses were used. In each case the comparison is made between four horses and a tractor with a drawbar rating between 12 and 18.5 hp.

	Man-Hours Per Acre			
	With tractor		With four horses	
	Average	Range	Average	Range
Disking	.46	.29-.58	.70	.35-1.10
Harrowing	.26	.19-.38	.40	.23-1.00
Planting	.46	.32-.84	.62	.42-1.02

On many farms there are horses and a tractor, one or the other of which may be used to perform some of the field operations. Obviously farmers should be encouraged to use tractor power in preference to horses whenever a saving in time will result.

Field practices in seedbed preparation must be determined for each individual set of conditions. The object must be to obtain

[3]Anderson, Arthur William. A Study of the Effect of Shape and Size of Field on the Labor and Power Expenditures for Crop Production. Unpublished Thesis. University of Minnesota. August, 1942.

a satisfactory seedbed physically, to eliminate weeds as much as possible, and to plant the flax seeds in shallow soil and cover them. Early planting is important. Flax should be planted as early as the land can be worked.

The previous year's crop and the weediness of the field have an influence on the operations necessary for a seedbed. In many areas plowing is considered essential as a means of covering surface trash, of controlling weeds, and of obtaining the proper physical condition of the soil. To facilitate shallow planting at an even depth and have the seed properly covered, there should be as little trash on the surface as possible.

From the standpoint of weed control the advisability of plowing may sometimes be questioned because while some weeds are killed and some weeds are buried, others that would probably not have germinated are brought to the surface and placed in a favorable situation for germination. Disking of small grain stubble immediately after harvest, in preparation for flax the following year, is an excellent practice. Weed plants are killed and weed seeds are encouraged to germinate. When several soil tillage operations are performed the same season it is advisable to provide for an interval of time between them to permit weed seeds to germinate and thus be destroyed, hence disking immediately before plowing cannot be generally justified, especially in the emergency.

ONE PRACTICE, WHERE CORN PRECEDES FLAX, IS TO PREPARE SEEDBED BY DISKING AND HARROWING

When corn precedes flax, the common practice in many areas is to prepare the seedbed by disking and harrowing in the spring immediately before planting. Some rake the cornstalks and burn them. This makes necessary not only additional working with the disk, but the labor required for assembling and burning. There seems to be no evidence that burning cornstalks is advantageous and many excellent farmers state that it is not necessary or even advisable.

A practice followed with considerable success by some farmers in western Minnesota and recommended by J. L. Adams, manager of Gilfillan Farms, at Redwood Falls, calls for double disking the stalk field in the spring as soon as the ground will permit. It is advised that this disking be done at right angles to the direction in which the corn picker went, even though it is rough going, because a larger number of stalks will be cut than by disking in some other direction. The field is then harrowed once in preparation for planting. To be most effective as a weed control measure, this harrowing should be done immediately before planting. The harrowing should be done in the same direction in which the field was disked. A flexible harrow seems to be preferable and a second harrowing would be detrimental because it would bunch the stalks too much. Drilling, which follows the harrow immediately, must also be done in the same direction. No further attention is given the field before harvest.

Flax is commonly harvested by one of two methods, namely, (1) cutting with a binder, shocking, and threshing with a stationary thresher, or (2) harvesting with the combine, either direct combining or windrowing, and picking up from the windrow with the combine.

In most flax-growing areas binding, shocking, and threshing is probably the method most commonly used and is probably the one that calls for the largest number of man-hours per unit of crop. It is difficult to find justification for continuing the practice. Apparently custom and the availability of machinery and equipment for handling it in that way are responsible.

The use of the combine method is recommended by those who have tried it. It permits savings of both power and labor over other methods. As between windrowing in comparison with direct combining, local conditions will determine which is to be followed. Although windrowing calls for an additional operation, it is necessary under some conditions such as the presence of weeds or adverse weather conditions during the harvest season.

Fields relatively free from weeds can, under most conditions, be combined direct. Flax will not shatter much or lodge badly if it is permitted to remain uncut until it is dead ripe. If, however, the field is weedy, and especially if there is considerable precipitation during the harvest season, weeds will be encouraged to develop to the extent that they will interfere seriously with direct combining. Under such circumstances, windrowing at about binder harvest time will permit the weed plants to dry thus causing a minimum of interference with threshing.

A question might be raised with regard to the risk of spoiling or losing the crop during a wet harvest season, if it is lying on the stubble in a windrow instead of in the shock. While there exists a difference of opinion in this regard, farm managers and operators who have had experience with both methods state that there is probably no more risk involved by having the crop in the windrow than in the shock. That fact plus the large saving in labor offered by the combine method suggests that the latter should be used wherever possible.

Doubtless the availability of combines is the limiting factor in effecting a rapid and general change to that method of harvesting. Windrowing may be accomplished with the binder which is on hand or readily available on every farm. There are various methods of adapting a binder for windrowing. Perhaps the most simple is to remove the trip hook and the bundle carrier and to fasten to the binder, about a foot above the ground, a sheet iron pan or trough with the front end several inches higher than that of the rear end. The function of the pan is to receive the impact of the material as it drops from the binder deck so it may be laid loosely on the stubble as it slides out of the trough.

Two characteristics of the flax crop are significant in making combines available for its harvest: (1) When planted the same time as spring wheat (which is the recommended time for planting), it will mature about 10 days later; (2) it will not shatter or lodge badly if permitted to remain uncut for a short time after it is ripe. Since cereals should be harvested before flax, combines used for the cereals should be available for flax when it is ready, and since the flax crop will remain without significant damage for a week or ten days after it is ready for harvest, a single combine can be made to harvest a considerable acreage. The possibility of transporting combines moderate distances for harvesting flax also suggests itself. The most practical method of using a single machine on a number of farms doubtless is by the owner of the machine, or someone hired by him, doing the work.

SUMMARY

Because the flax stem is not leafy or bushy it does not shade the ground like the cereal crops and consequently is not as successful a competitor of weeds as are the latter.

Much less time and effort are required to eliminate, in so far as possible, weed seeds and pieces of straw carrying disease spores from flax seed than to cope with the weeds and diseases in the crop. Hence clean seed is of utmost importance.

The ordinary farm fanning mill is capable of doing a fair job if it is equipped with sieves of enough sizes to make possible the use of sieves with correct size openings. It may be necessary to run the seed through the fanning mill two or three times.

A combination seed cleaning outfit consisting of a fanning mill and a disk cleaner has been found highly efficient in producing clean seed and in the use of labor for that purpose. Such an outfit or other commercial cleaner should be available for community use either through cooperative ownership or at a local seed store or elevator.

There are large differences between individual farmers in labor and power expenditures for seed preparation. These are of three types: (1) Efficiency of the operator, (2) character of the facilities such as size of fields and power units, and (3) practices followed.

Increasing field sizes will improve field operating efficiencies. This increases in importance as the size of field machines increases.

The size of the power and machine unit and speed of operations are important factors in labor efficiency.

For most field operations savings in time will result from the use of tractors instead of horses.

Early planted flax produces highest yields. It should be planted as soon as the land can be worked.

Although plowing is considered essential for a good seedbed for flax in many areas, it may do more harm than good by bringing to the surface old weed seeds that had not germinated.

While disking of grain stubble immediately after harvest in

preparation for flax the following year is usually well worth while, disking immediately before plowing cannot be generally justified, especially in the emergency.

It is advisable to separate succeeding tillage operations by a period to allow weed seeds to germinate.

It is not necessary to burn cornstalks if corn stubble land is prepared for flax by disking.

Double disking and harrowing only once with a flexible harrow immediately before planting is considered a satisfactory method of preparing a seedbed for flax on comparatively clean ground in western Minnesota.

The use of the combine method of harvesting flax is recommended by those who have tried it. It requires the least labor of any method. Windrowing is necessary in the presence of weeds or when adverse weather prevails during harvest.

Because flax planted the same time as spring wheat will mature about 10 days later, and because it will not shatter or lodge badly for a short time after it is ripe, combines used for cereals should be available for flax and a single combine can be made to harvest a considerable acreage.

"Down to Essentials"

TO THE EDITOR:

I WAS interested in R. W. Trullinger's suggestion in the editorial, entitled "Down to Essentials," in AGRICULTURAL ENGINEERING for April.

I have always felt that most of our machinery has been pretty well freed from non-essential features. Certainly it is not as heavy and cumbersome as it used to be. Most of the improvements have been made with the end objective of improved efficiency, labor saved, economy and safety, convenience, and comfort for the operator. If there are non-essentials that do not contribute to these ends, they should be eliminated.

On the other hand, any change during the present war emergency as a means of saving materials might result in no particular total saving because of the effect on the result obtained, that is, additional labor and effort to operate and the lack of safety of the machine when stripped to its bare essentials.

At the present time, it seems to me we need more than ever before to make more use of existing machines and to make our power more effective by using combinations of machines to the end that we can get the job done with less labor, as well as less machinery. I realize that the standard of production may have to be reduced due to the lack of machines and labor, but the machines we do have ought to be just as satisfactory as they can be made.

In principle, I think the suggestions made by Mr. Trullinger fit into the ideas of our (A.S.A.E.) Committee on Machinery, Power, and Labor Efficiency in Agriculture. At any time, whether under normal conditions or during the war emergency, if seedbed preparation, planting, harvesting, etc., can be accomplished with less machinery, we should work to that end. However, during this emergency with labor at a premium, don't strip machinery to bare essentials if by so doing we lose in efficiency, with more labor required, and if the machine is made less safe and less satisfactory to operate. I am also inclined to believe that a change would interfere with the process of manufacture which might be a disadvantage now.

E. W. LEHMANN

Head, agricultural engineering dept.
University of Illinois

TO THE EDITOR:

I PERSONALLY check with the statements of Professor Lehmann in the foregoing letter commenting on Mr. Trullinger's editorial. Frills are out on farm machines. They have been out; competition forced them out over the past many years. Even the wooden peg breakpin for shovel shanks while requiring less materials than spring-trip shanks would probably require additional material in other machinery such as cultivators and tractors to compensate for lost time.

There may be some opportunity for simplification on the part of individual companies; however, I am certain most such possibilities have been looked into because of the current need for conserving materials.

I heard a talk recently in which one of the points made was that "No one of us knows as much as all of us." That point somewhat illustrates the farm equipment industry. When "one" in the industry whose thinking clicks with the thinking of a mass of farmers, then that "one" immediately acquires a reputation. On the whole, however, the mass of farmers run the farm equipment industry. There are those who think that the department heads of the various companies run the industry; they do in part only, but when it comes to fulfilling demands of what farmers want, those department heads are mere filters for the demands of the consumers. So let's not get too hasty and conclude we can do a lot to eliminate materials and cause our engineering to be confused. In fact, my opinion is that we may have congealed progress in equipment design for the duration by the following things:

1 Limitation orders based on numbers of units rather than over-all tonnages of materials for each class or type of machines. This one thing in itself has cramped the freedom or removed the incentive of the engineer in eliminating some possible frills.

2 The limitation orders have frustrated selections of the newer machines which may offer labor-saving features. This is 1943 and specifications on equipment production schedules are in readiness for 1944. Yet we select now for a greater war effort on the basis of 1940 production for which specifications were set in 1939. Therefore, we are five years behind time in our selection. Further, any units coming into production in 1940 were low in volume or perhaps not produced at all; therefore, no production will be had in 1944, except through appeals, which in my opinion complicates the production of new units to almost the point of stoppage.

3 This congealing activity has delayed new developments which we now need more than ever because of the great food output necessary and less labor with which to produce it.

I do not wish to imply that Mr. Trullinger has not made a contribution in his thinking; I point out merely that we should carefully consider such approaches. I do feel that Mr. Trullinger has not given the industry's engineers full credit for the study which they have made on weight and cost eliminations accomplished over the past several years.

We do have a job, as he points out: "The place of each cultural operation involving a separate farm machine in the economics of production of a crop is now a pertinent one. Not knowing these facts now any too well, we are not in any too good a position to convince the war production men controlling the nation's supply of raw materials . . . . that these should be allotted to the manufacture . . . . of farm machinery."

If we are to undertake this as an analysis of the place of the separate farm machine, I believe we should approach the matter first on the overlapping use of the separate machine as it is applied to a diversity of crops or products on a single farm. In this manner we do not approach an optimum single machine use, but agriculture as it is practiced with machines.

No group, except farmers, has the facts as accurately as the farm equipment engineers. Farmers know what they need, but since it takes on the average of 8½ months from materials order date to deliver these materials in finished form to farmers, they know too late for the industry to provide tools in less than one season of crop production for most crop machinery.

Agricultural engineers in the field of education or research have some facts, but indirectly. I observe some so-called facts are based on inadequate data, faulty samples, and knowledge of area situations not applicable to the domestic requirements of the country as a whole. Many of the men in this group have dispensed personal opinion.

I reiterate my point that the mass of farmers know best what they need or can use in simpler designs or types of equipment to save labor, and thus to produce food at highest efficiency. Our profession and our Committee on Machinery, Power, and Labor Efficiency in Agriculture may be helpful in clearly stating the requirements so that farmers may "pull up" their efficiency. We may also be helpful in clarifying the situation as regards farm equipment engineering progress during the war.

FRANK J. ZINK

Director, research department
Farm Equipment Institute

Performance of Small Domestic Dehydrators

By L. W. Gray
MEMBER A.S.A.E.

EXPERIMENTS now indicate that most fruits and vegetables can be dried successfully by artificial means, known as dehydration. Dehydration may be said to embrace two fields, commercial and domestic. The general characteristics of the two are very similar, but in the commercial field requirements are very rigid. This does not mean that domestic dehydration, if properly done, is subject to any laxity, but rather opportunities are offered for the dehydration of the farm and garden surplus that meet all domestic requirements which are not so rigid as in the commercial field and offer many opportunities for experimental work. These same products have, however, full opportunity of entering the commercial field, if and when they meet the general standardization requirements of this field. This means that the farm and garden surplus can be dehydrated, packed, and stored for domestic consumption or placed upon the market through commercial distribution agencies that may exist.

The community type or small individual domestic dehydrators are the most common means of domestic dehydration available to those interested. Small domestic dehydrators are generally available in several different models, some of which are very simple in design and operation and depend upon some heat source of supply and natural air movement with very little attempt to control temperature or humidity. There are other models that are more elaborate, being well insulated where temperature, humidity, and the rate of air movement is controlled. First cost of the unit is of prime importance and should be kept at a minimum to insure volume usage. A good product can be produced with the simpler units and there may be some question as to the economic justification, from the domestic standpoint, for a unit too high in price. Some cabinet makers and distributors are making a well-finished combination kitchen cabinet and dehydrator which insures twelve months profitable usage of the cabinet at a price that the market will accept.

The economic factors in the preservation of the farm and garden surplus affecting the standard of living in the rural and farming areas, increased farm profits, and better nutritional and food values, all contributed materially to the value of the proper preservation of the food surplus. Dehydration of food products offers one of the most economical and practical means of preserving the surplus, and the small domestic units can probably be utilized to the best advantage where community service is not available.

The general operation of the small domestic dehydrators is not as critical as the larger commercial units, but to produce an acceptable product with the proper moisture content requires experience. There is no substitute for this experience and apparently no general formula for the successful operation of these units. To dry out a product is a simple task—but will it keep, and can it be stored without deterioration after it has been dehydrated?

Some fruits and vegetables lend themselves readily to dehydration; a rough rule is that varieties suitable for canning and quick freezing are suitable for dehydration. Dehydration encounters many problems and consideration must be given to the section of the country where the product is grown, type of soil, cultural methods, irrigation where moisture can be controlled, and other factors that may affect the fresh product. In Georgia some of the fresh products dehydrate readily, others do not. Bermuda onions grown in Georgia do not dehydrate properly, while other varieties such as Ebenizer, White Portugal, red and white Creole grown in certain sections of the state do. Certain varieties of cabbages contain excess moisture with too large cell texture; rutabagas, Irish and sweet potatoes, beets and carrots must be selected for their adaptability for dehydration if a properly dehydrated product is to be secured. All these factors affect the operation of the small domestic dehydrator, but there are ample selections to be had for the successful operation of these units.

Paper presented December 8, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Rural Electric Division. Author: Manager, rural service division, Georgia Power Co.

What shall we dehydrate? It may be emphasized here that this is no means for disposing of inferior products.

The main factors in domestic dehydration are (1) quality products, properly matured, (2) protection against dust and insects during drying time, (3) completeness and speed of drying, and (4) containers and correct storage of the dried product. Food to be dehydrated should be carefully selected and prepared as for immediate use. It should be harvested to avoid the direct rays of the sun just prior to being placed in the drier. If this is not possible, place the product on refrigeration at a temperature of around 40 F for a period of not more than 12 to 15 hr. Vegetables should be steam blanched to stop enzymic action and to retain more of the mineral and vitamin content. Fruits are sulfured for the purpose of retaining color and for the tendency to preserve certain vitamins. The time required for drying depends upon the size of the product, texture, moisture content, humidity, air temperature, and the rate of air movement. The moisture content should range, after dehydration, from around 3 to 5 per cent in the leafy vegetables such as spinach, kale, mustard greens, and cabbage, to around 8 to 10 per cent in sweet potatoes. Fruits will retain from around 20 to 24 per cent of their moisture content. The drying time depends upon the product, ranging from 2 to 3 hr for spinach and cabbage, 6 to 8 hr for corn, and 10 to 12 hr for sweet potatoes. Fruits such as peaches, pears, apples take from 12 to 14 hr. Experience has shown that one bushel of peaches (Elbertas) will turn out 4½ lb of the dried product; one bushel of apples, 3½ to 4 lb; one bushel of pears, 5 lb, and one bushel of figs, 4½ lb. The net dried product will range from 3 to 7 per cent of the original weight in spinach and cabbage, 5 to 9 per cent in onions, carrots, and beets, from 8 to 15 per cent in mustard greens and rutabagas, and 15 to 30 per cent in Irish and sweet potatoes.

Care should be exercised in preparing the vegetables for drying as the trimming losses are frequently very heavy ranging from 10 to 15 per cent in rutabagas, 20 to 30 per cent in carrots, 30 to 40 per cent in mustard greens, and 50 to 65 per cent in spinach.

Extreme care should be taken to see that the product is properly dried with the correct amount of moisture remaining or the product will not keep in storage.

The percentages and time given are subject to variations and the whole process of dehydration is undergoing experiments that may change the entire procedure. Some authorities seem to think that the drying process is too long, that the blanching period is at the wrong temperature and the waste excessive, and that better controlled or supplied humidity will result in a much superior product. There is much to be learned about the dehydration of fruits and vegetables.

The idea of artificial domestic dehydration is comparatively a new idea brought out as a war measure and knowledge concerning it has been somewhat limited. To be effective it must be popularized through education and demonstration, and various means of doing this are under way. The agricultural extension service, the vocational school system, the rural electric membership corporations, and the utility companies in Georgia are engaged in a general educational campaign on dehydration. More than 175 small domestic dehydrators that have been locally constructed are now in the hands of vocational schools, county agricultural agents, and others for demonstration purposes. Group meetings have been held in a large number of vocational schools and lectures given. Several of the schools have large community types of dehydrators which process food products on a community basis.

Preserving and storing the surplus food supply will continue as a major activity during the emergency. Dehydration due to its advantages in reduced volume will or has already come into prominence. The degree of success of dehydration, particularly domestic dehydration, will determine to a large extent the degree of success of the agricultural war program and the chance of the survival of dehydration in the postwar period.

NEWS SECTION

A.S.A.E. "War Conference"

THE program being planned for the annual meeaing of the American Society of Agricultural Engineers to be held at Purdue University, Lafayette, Indiana, June 21 to 23, will feature subjects of such timely importance with reference to the current emergency as to make it distinctly a "war conference."

The first formal session of the meeting, Monday forenoon, June 21, will be in the nature of a symposium on problems and policies concerning supply, conservation, substitution, allocation, etc., of equipment and materials to meet farm needs in the war emergency. The session will open with a report by the War Activities Committee of the Society. This will be followed by a series of brief statements by a panel of experts representing WPB, OPA, WFA, and others, after which the remainder of the period will be devoted to general discussion and answering of questions by the experts.

The afternoon session of Monday, June 21, will feature a general program which will include the annual address of the President of the Society, H. B. Walker, and an address by a second speaker.

The annual business meeting of the Society will be held at the close of this session.

The College Division of the Society is planning a special program for Monday evening.

The forenoon of the second day of the meeting, Tuesday, June 22, will be given over to concurrent programs of the Society's four technical divisions. The Farm Structures Division has planned a program for this period around the topic "Farm Building Standards and Rational Design." This will include two major papers, one on evolution and use of building standards in rational design and the other on proposed farm building standards. In addition three representatives of the building materials industry will discuss what industry is doing to develop better farm buildings. The Rural Electric Division program will feature these subjects: electric motors and their availability, motor repair clinics, electro-agricultural equipment for war and peace, organizing rural electric specialists for emergency situations, suitable types of food dehydrators for home use, and preventative maintenance of electric farm equipment. The Power and Machinery Division program for this period is built around the topic "Ways to Boost Efficiencies and Economies in Wartime Farm Production," and will include these papers: a method to increase efficiency in fertilizer application, saving critical poisons in insect pest control, the American hemp program and the machinery phases thereof, new developments in sugar beet production, prevention of rust in farm machinery, and a unique idea worked out in a farm machinery repair campaign.

A general program has been arranged for the afternoon of Tuesday, June 22, and will consist of three outstanding addresses, the first by W. G. Kaiser, agricultural engineer and manager, cement products bureau, Portland Cement Association, on the engineering challenge of farm structures, another by A. A. Potter, dean of engineering at Purdue, on the effect of war on engineering and engineering education, and the third by M. L. Nichols, chief, division of research, U. S. Soil Conservation Service, on wartime strategy for agricultural engineering.

The regular annual dinner of the Society will be held Tuesday evening, with George W. Iverson as master of ceremonies. As usual the annual dinner will be the occasion for the formal awarding of the John Deere and Cyrus Hall McCormick gold medals, and the Farm Equipment Institute trophy to a student branch of the Society, and for the inauguration of the new president of the Society.

The third day of the meeting, Wednesday, June 23, will be devoted exclusively to programs of the four technical divisions. The Farm Structures Division program for Wednesday forenoon features the general topic "Planning Ahead for Farm Structures," and includes a report of the Society's Committee on Farmhouse Standards, an address on trends in farm building construction, a symposium on farm storage of soybeans, and an example of prefabricated grain storage. The rural Electric Division program will deal with the topic "Farm Freezing and Storage of Food," and will include two papers on experience with farm freezers, one in New York and the other in Michigan, a paper on the correlation of compressor size, insulation thickness, and eutectic value of farm freezers, and a report of the Committee on Freezing of Agricultural Products. For this period the Power and Machinery and Soil and Water Conservation Divisions are arranging a joint program for which the following papers are planned: an improved implement for mole drainage, progress in integrating farm machinery in soil erosion control measures, building broad-base terraces with mold-board plows, and a symposium covering the experiences of engineers in state colleges and farm equipment companies on adapting farm machinery to mulch culture.

During the afternoon of June 23, each division will present a separate program. The Farm Structures Division program is built around the topic "Relation of Farm Building to the War Effort," and includes papers on the following subjects: building needs for wartime agriculture, how agricultural engineers can help the materials dealer, a farm building repair clinic, and a report of the farm structures subcommittee of the Society's War Activities Committee. The Rural Electric Division program will feature the general topic "Homemade Electric Equipment for Wartime Needs," and will include papers on homemade brooder clinics, vo-ag activities in homemade equipment, portable grain elevators, and homemade electric brooders.

The Power and Machinery Division program for this period lists papers on labor duty in harvesting ensilage, overlapping use of farm equipment, evaluation of farm machines in terms of crop values and labor efficiency, and emergency methods and equipment to meet wartime labor, materials, and equipment shortages.

Programs of the Soil and Water Conservation Division to be presented during the forenoon of Tuesday, June 22, and the afternoon of Wednesday, June 23, are now being planned and will shortly be ready for announcement.

Most of the speakers for the various subjects scheduled have accepted places on the program, copies of which will shortly be available for distribution. Requests for copies of the program or additional information about it should be addressed to A.S.A.E. headquarters at Saint Joseph, Michigan.

A.S.A.E. Meetings Calendar

June 21 to 23—Annual Meeting, Purdue University, Lafayette, Ind.

December 6 to 8—Fall Meeting, La Salle Hotel, Chicago, Ill.

Ag Engineers Field Day

AS PREVIOUSLY announced the Washington (D.C.) Section of the American Society of Agricultural Engineers will hold a field day at the Beltsville (Md.) Research Center of the U. S. Department of Agriculture on May 21st. This will consist of a tour of the Research Center to observe work of various USDA bureaus in progress. The Washington Section extends a cordial invitation to agricultural engineers to attend this field day.

While reservations for the tour will be accepted until 10:00 a.m., May 19, it is urged that reservations be made if possible by Monday, May 10. Unless other arrangements are made, cars will pick up passengers in front of the Department of Agriculture administration building in Washington not later than 8:00 a.m. on May 21st. Reservations should be made either by calling C. A. Logan, chairman of the Section, at Beltsville Research Center (telephone Warfield 4200, Extension 6) or C. L. Hamilton, secretary of the Section (telephone Republic 4142, Extension 2751).

If public transportation is used between Washington and Beltsville, the Trailways or Greyhound bus is recommended. These buses run every half hour, and it is suggested that persons using them leave on the 8 o'clock bus on New York Avenue between 11th and 12th Streets. Transportation for those without cars will be provided at Beltsville.

The program will start promptly at 9:00 a.m. at the Plant Industry station on the west side of the Boulevard at Beltsville, and the group will meet in front of the administration building (the building with the big clock). Those arriving late should go direct to the Research Center where a large map of the Center will be found by the Information House just inside the entrance gate, and from which it can be determined where the group making the tour can be found at various hours during the day.

The program for the day is as follows: From 9:00 a.m. to 10:00 a.m., the greenhouse equipment for soilless culture, rubber investigations, etc., of the Bureau of Plant Industry, Soils and Agricultural Engineering, will be visited; *(Continued on page 168)*

NEWS SECTION

(Continued from page 166)

from 10:15 to 10:50 a.m., dairy cattle feeding and demonstration of tractor-powered manure loader at the Bureau of Dairy Industry building; 11:00 to 11:45 a.m., meat dehydration and equipment at the Bureau of Animal Industry; 11:55 a.m., to 12:20 p.m., production of cotton hosiery at the Home Economics Textile Mill; 12:30 to 1:00 p.m., home dehydration equipment of the Bureau of Human Nutrition and Home Economics; 1:00 to 2:00 p.m., luncheon at Log Lodge; 2:10 to 3:00 p.m., inspection of agricultural engineering work and new insecticide equipment at the BPISAE and the Bureau of Entomology and Plant Quarantine; and from 3:15 to 5:00 p.m., several projects of the Soil Conservation Service, Nursery and Hillculture investigations.

Personals of A.S.A.E. Members

W. M. Hurst, senior agricultural engineer (BPISAE), U. S. Department of Agriculture, is author of Circular No. 667, entitled "Fiber-Flax Machinery and Processing Operations in Oregon," recently issued by the Department.

Roy M. Magnuson, has resigned as chief engineer, Bean-Cutler Division, Food Machinery Corporation, to organize his own business under the name of R. M. Magnuson Engineers, and to engage in design, development, and production activities. The business is located at San Jose, Calif.

Stephen J. Mech has been transferred to Prosser, Washington, where he is project supervisor for the hydrologic division (SCS), U. S. Department of Agriculture, in the irrigation branch experiment station there. He previously held a similar position with the SCS soil conservation experiment station at La Crosse, Wis.

W. R. Peterson has recently taken a position in the engineering department of Harvester Co., and will be located at the Company's farm near Hinsdale, Ill. He was formerly an instructor in agricultural engineering subjects at the Northwest School of Agriculture of the University of Minnesota, Crookston.

Earle K. Rambo, extension agricultural engineer, University of Arkansas, is author of an article, entitled "Estimated Costs of Owning and Maintaining Various Farm Machines," which appeared in the Arkansas Agricultural Extension Economist for March 1943. Copies of this article are being sent to state extension agricultural engineers in accordance with a plan for exchanging information on farm machinery.

James L. Strahan, formerly a regional engineer of the USDA Farm Security Administration in charge of farm construction work in the eleven northeastern states, has joined the Flintkote Company as agricultural engineer. In his new job, Mr. Strahan will be concerned with the development and marketing of new products and new techniques in farm building construction. In his work as regional engineer of FSA he has supervised the rehabilitation of more than 1000 farms.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Walter L. Brantley, Sr., superintendent, Western Division Shops, United States Sugar Corp. (Mail) P. O. Box 406, Clewiston, Fla.

James H. Cooper, lecturer in agricultural engineering, Macdonald College, Macdonald College, P.Q., Canada.

Gerald Geraldson, chief engineer, J. I. Case Co., Rockford, Ill. (Mail) 412 Calvin Park Blvd.

Dan J. Iverson, engineering consultant, Vermiculite Research Institute, 135 S. LaSalle St., Chicago, Ill.

Kenneth L. Magee, chief engineer, J. I. Case Co., Burlington, Iowa. (Mail) 403 Iowa St.

Tolmar Nelson, chief engineer, tractor works, J. I. Case Co., Racine, Wis. (Mail) 1122 Arthur Ave.

Paul R. Schroeppel, engineer, J. I. Case Co., Rockford, Ill. (Mail) S. Independence Ave.

J. K. Skillings, manager, sales promotion, The Texas Co., 135 E. 42nd St., New York, N. Y.

William P. Wreden, owner and manager, Pinole Land and Cattle Co., P. O. Box 84, Burlingame, Calif.

TRANSFER OF GRADE

R. Erwin Jezek, assistant agricultural engineer, Emergency Rubber Project, (BPISAE), U. S. Department of Agriculture. (Mail) P.O. Box 1609, Salinas, Calif. (Junior Member to Member)

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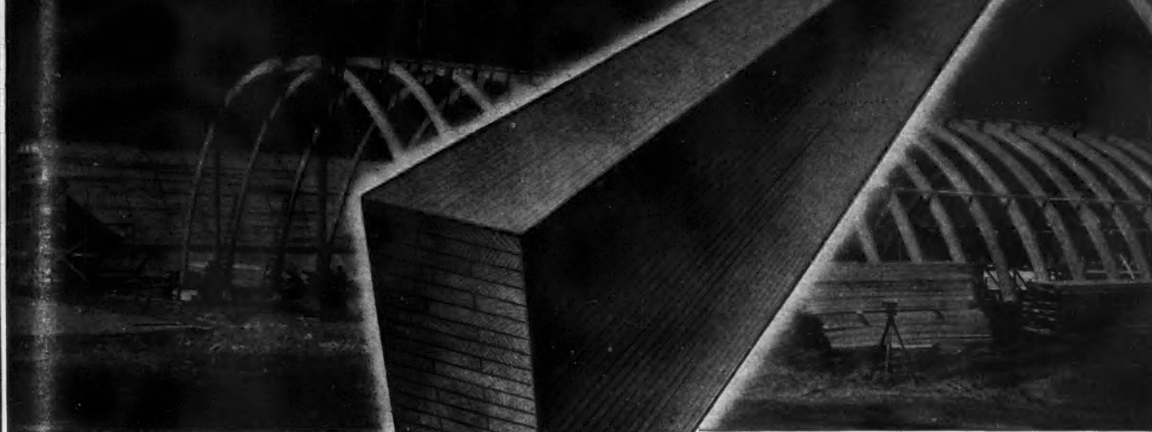

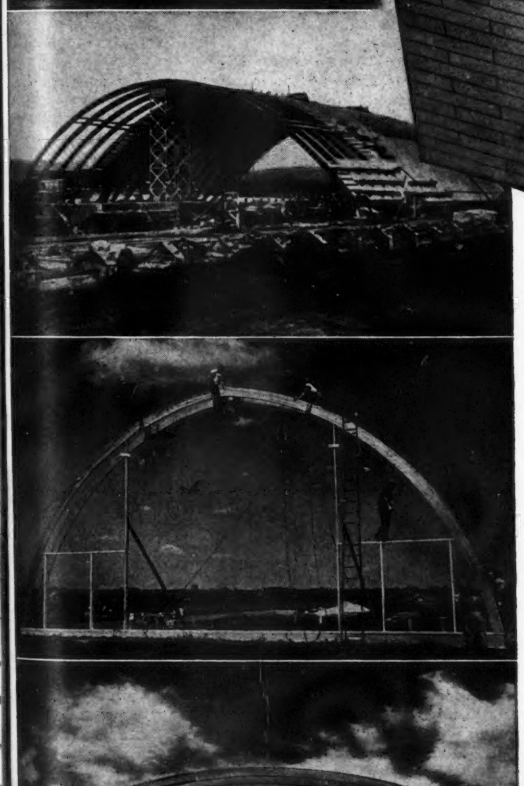

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Illustrated technical literature on the design and manufacture of glued laminated framing members and a special folder on farm buildings will be mailed on request.

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Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

LINING A LEAKY IRRIGATION CANAL WITH CLAY SAVES BOTH WATER AND SOIL: WATER LOST FROM UNLINED CANALS WOULD IRRIGATE MANY ADDITIONAL ACRES, *O. W. Israelsen.* (Coop. USDA et al) Farm and Home Sci. [Utah Ag. Exp. Sta. (Logan)], 2 (1941), No. 3. In canals carrying an average flow of from 23 to 72 cfs the average seepage losses were found to be from 2.1 to 10.7 per cent per mile, justifying a lining cost of from 1.8 to 8.9c per sq ft on the basis of the water saving effected. A further advantage was found in the lowering of water tables in the vicinity of the canals with resultant diminution of the risk of alkali damage. The average cost of lining with suitable clays was about 3c per square foot. Studies of the available materials showed that some of the clay soils of the area are sufficiently low in permeability to justify their use in lining canals to prevent seepage losses, whereas some soil materials which irrigators thought might be good are so high in permeability as to be of little or no value for lining canals. Hand tamping and tractor-driven roller compaction were both used in an experimental lining of a 4,000-ft section of a canal showing a high rate of seepage loss. This canal showed coefficients of permeability ranging from 30.4 to 65,000 ft per year. After the completion of a lining of 3 in of Oasis clay covered with from 0.5 to 1 in of gravel, the permeability coefficient became reasonably constant and had an average value of 0.124 ft per year. Several days' operation of the canal at its maximum capacity of 150 cfs beginning a few days after completion of the lining did not cause serious lining erosion, and after one month of operation a large part of the lining had resisted erosion.

CREOSOTED TAMARISK FENCE POSTS AND ADAPTABILITY OF TAMARISK AS A FINE CABINET WOOD, *G. E. P. Smith.* Arizona Ag. Exp. Sta. (Tucson), Tech. Bul. 92 (1941). This bulletin is in two parts, of which the first, concerned with creosoted tamarisk fence posts, takes up the tree itself, its climatic adaptation, botanical characteristics, the characteristics of the wood, and the growing, cutting, and seasoning of tamarisk; coal-tar creosote and alternative materials; and creosoting investigations. It was found that the condition of the home-treated fence posts after 5 yr indicated a useful life of at least from 12 to 15 yr. Creosoting by the open-tank method is recommended.

The second part of the bulletin deals with the adaptability of tamarisk for use as fine cabinet wood. This section of the bulletin is presented as a preliminary report, and definite conclusions are not yet offered. On the basis of the tests thus far completed, tamarisk wood is described as very heavy, very hard, strong, moderately stiff, with large shrinkage, and with high shock resistance. Machining tests on a small part of a single bolt indicated that the wood turns about as well as birch and maple. In planing (30-deg cutting angle only), the sample tested was found to rank fair and to be in the same class as red gum. The boring qualities place tamarisk in the oak class.

A PRACTICAL SEED-COTTON MOISTURE TESTER FOR USE AT GINS, *G. E. Gaus, C. S. Shaw, and W. H. Kliever.* U. S. Dept. Agr. (Washington) Cir 621 (1941). The tester is designed to register the hygrometric condition of the air confined within a mass of seed cotton by means of wet-bulb and dry-bulb thermometers, over which the air to be tested is drawn by suction provided by a vacuum cleaner. Drawings and a bill of material for the construction of the tester, from standard pipe fittings and inexpensive accessories, are included. A conversion table gives equivalent moisture content corresponding to the range of relative humidities indicated by the tester when used with seed cotton. A coefficient of correlation with drying-oven moisture determinations of 0.94 and a standard error of estimate of 1.48 per cent were found.

A moisture-content calculator employing a set of adjustable wet-bulb and dry-bulb temperature integrating scales for direct reading of corresponding moisture content from temperature readings made with the moisture tester is also described. A bill of material and specification for the construction and assembly of the calculator are included, and it is shown in photographs but not in working drawings.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE NEW HAMPSHIRE STATION. New Hampshire Ag. Exp. Sta. (Durham), Bul. 330 (1941). This report notes work by W. T. Ackerman on the design of small potato storages for farm use, in which heat requirements have been cut down in some types of storage and other progress made, and on dehydration and processing of medicinal herbs, a drier capable of dehydrating 200 lb of green material to U. S. P. specifications in from 30 to 60 hr having been constructed.

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(Continued from page 170)

HOG BARN HEATING AND VENTILATION, *A. Severson*. North Dakota Ag. Exp. Sta. (Fargo) Bimo. Bul. 4 (1941), No. 2. To prevent concrete floors from becoming too cold, especially during farrowing, the author used warm-air runways under the floor. Those here described were placed 1 ft apart, each was made 18 in wide and 8 in deep, and the ducts were placed 4 in below the surface. Air heated by a stove at one end of the barn was driven through these ducts by a booster fan and was returned to the furnace. The ducts were placed under the farrowing pens and were designed to maintain a floor temperature of about 102.5 F, the body temperature of the animal. The importance of insulating the foundation walls, as, for example, with a 2-in layer of mixed asbestos powder, vermiculite, and cement poured inside the foundation walls, is emphasized. Heating and ventilation should be carefully considered either in building a new hog house or in remodeling an old one. Draftiness must be avoided, but building up an excessive concentration of carbon dioxide and too high a humidity through inadequate ventilation may cause pneumonia.

THE ALL-ELECTRIC GREENHOUSE, *J. Roberts and S. E. Wadsworth*. Washington Ag. Exp. Sta (Pullman), Bul. 404 (1941). This bulletin mentions the lean-to, the separate all-glass, and the insulated types of electric greenhouses but is mainly concerned with the construction of the last-named type. A bill of materials for a standard 8x12-ft house shows also the additional quantities of each dimension of lumber and of other materials required for each 3-ft increase in length. The unit described is to be framed of 2x4-in lumber. All-weather plywood is to be applied inside and outside the frame, insulation being placed between the two plywood layers. Working drawings show the detail of construction. Heat was found to be satisfactorily supplied by a 1,300-w fan air heater and two 440-w soil-heating cables laid one in each soil bench. The heating elements are to be thermostatically controlled. Data obtained in tests of electric power requirement are tabulated. The approximate costs of construction are given. Related topics taken up are soils for the greenhouse bench, flowers suggested for the small electric greenhouse, vegetables, artificial light, and suggestions for operating the electric greenhouse.

THE MISSOURI SOIL SAVING DAM: LOW-COST STRUCTURE FOR USE IN FARM PLANS FOR WATER MANAGEMENT, *J. C. Wooley, W. M. Clark, and R. P. Beasley*. Missouri Ag. Exp. Sta. (Columbia), Bul. 434 (1941). The dam is constructed on a slope between 1.25 : 1 and 1.5 : 1, and thus utilizes the angle of repose of the soil to avoid the necessity of heavy construction. The cut-off wings are also constructed on a slope extending back into the barn, allowing the earth to lie on the sloping wing and avoiding, to a large degree, the tendency of earth to pull away from the structures in dry weather, as from a vertical wall structure. Effects of shrinkage or freezing of the soil are minimized. The new structure is not anchored deeply in the ground, where its parts would be subjected to different conditions and thus to varying stresses. The structure also consists of a combination of arches, avoiding excessive stresses encountered in straight-wall and corner construction. Wood forms, except for the velocity check, are not needed. Earth forms are produced by cutting or building. The reinforcing mesh is pulled or blocked up 2 in above the earth, and concrete is floated (by means of a wood float) to a uniform thickness of 4 in. When it begins to set up, it is worked with a steel trowel to leave a dense weather-resistant finish. Working drawings are included. The proper use and placement of such dams are discussed.

Let Them Buy Bond

(Continued from page 142)

Contractors give bond for the faithful and timely completion of their contracts. As a matter of routine, officials and employes give bond for the safety of funds entrusted to their custody. In neither case is it a reflection on their probity, but a token of responsibility recognized and insurance against contingencies sometimes beyond their control. The same principle and the same practice should be adopted by organized labor, voluntarily and gladly.

For honest and responsible men, the cost of purchasing such bonds is trivial. The larger labor organizations should have no need to buy bonds. With something like ten million dollars a month surging into their treasuries, it would seem a simple matter to earmark a few million as a surety reserve. It would be a small price to protect the self-respect of millions of their members.

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